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A
MANUAL
OF
LOGARITHMS
AND
PRACTICAL MATHEMATICS;

FOR THE USE OF STUDENTS, ENGINEERS, NAVIGATORS, AND SURVEYORS;

COMPRISING

TABLES OF LOGARITHMS OF NUMBERS, LOGARITHMIC SINES AND TANGENTS, NATURAL
SINES AND TANGENTS; BAROMETRIC TABLES FOR CALCULATING THE HEIGHTS OF
MOUNTAINS; AND VARIOUS OTHERS USED IN NAVIGATION, SURVEYING, &c.

WITH

AN INTRODUCTION

CONTAINING AN EXPLANATION OF THE CONSTRUCTION AND USE OF THE TABLES;
/ ALSO A GREAT VARIETY OF FORMULÆ FOR COMPOUND INTEREST AND ANNUITIES,
MENSURATION, MECHANICS, AND PLANE AND SPHERICAL TRIGONOMETRY.



BY JAMES TROTTER,

Of the Scottish Naval and Military Academy; Author of "Lessons in Arithmetic,"
"A Key to Ingram's Mathematics," &c.

EDINBURGH:

PUBLISHED BY

OLIVER & BOYD, TWEEDDALE COURT;

AND

SIMPKIN, MARSHALL, & CO. LONDON.

MDCCCXLI.

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726.

ENTERED IN STATIONERS' HALL.

**Printed by Oliver & Boyd,
Tweeddale Court, High Street, Edinburgh.**

PREFACE.

THE chief design of this Publication is to supply a concise Mathematical Text-book, for the use of schools and professional men. The principal difficulty in producing a work of this kind arises not from the scarcity of materials, but from their superabundance; and the Editor has been especially anxious to introduce such Tables only as are of the most extensive application, and to exclude others which would have increased the price of the volume without enhancing its value. As the utility of Tables for practical purposes depends in a great measure upon their accuracy, the utmost care was exerted to attain this desirable end; the whole having been rigidly collated with the best works, British and Foreign, and numerous computations instituted with a view to test their correctness. They may therefore be fully depended upon in the nicest calculations.

In the introduction, clearness rather than elegance of language has been studied, and it is confidently trusted that the illustrations will be readily understood, and that the examples, which are performed at length, will greatly assist the student in arranging his materials in the most suitable form. The construction of the principal Tables has been explained in order to enable the learner, if he should think fit, to verify the results, and also to extend the decimal places farther in cases which require very great precision.

The various Formulæ given under the heads Compound Interest and Annuities, Mensuration, &c. have been principally selected from the volumes of BAILEY, HUTTON, BARLOW, GREGORY, and CAGNOLI, and as great vigilance has been exercised in superintending the press, it is hoped they will be found free from any material error. By such learners as have but a slight knowledge of Algebra, these formulæ will be preferred to Rules expressed in words; and they will in all cases prove extremely useful to Surveyors, Engineers, and Mechanics.

EDINBURGH, *January 1841.*

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MATHEMATICAL TABLES.

EXPLANATION AND USE OF THE TABLES.

TABLE OF LOGARITHMS OF NUMBERS.

Definition and Notation of Logarithms.

LOGARITHMS are a set of artificial numbers invented and formed into tables for the purpose of facilitating arithmetical computations. They are adapted to the natural numbers in such a manner, that by their aid Addition supplies the place of Multiplication, Subtraction that of Division, Multiplication that of Involution, and Division that of Evolution or the Extraction of Roots.

Let a series of numbers in arithmetical progression be adapted to another in geometrical progression, so that the least term of the one may correspond with the least term of the other, and the rest in order, thus,

Arith. Prog. 0, 1, 2, 3, 4, 5, 6, 7, &c.
Geom. Prog. 1, 4, 16, 64, 256, 1024, 4096, 16384, &c.

Now let it be required to multiply together any two terms of the geometrical series, as 16 and 64. This may be done by adding 2 and 3, the corresponding terms of the arithmetical series, for the sum 5 is the term corresponding to 1024, the product. Again, if we wish to divide any term of the geometrical series by any other, as 1024 by 16, we have only to subtract 2 from 5, the corresponding terms of the arithmetical series, for the difference 3 is the term corresponding to the quotient 64.

Hence the use of such an adaptation is manifest; but it is very limited in the present state of the series. We may, however, easily extend it by interposing an arithmetical mean between every two terms of the arithmetical series, and

a geometrical mean between every two terms of the geometrical series, when the number of the terms will be doubled, thus,

Ar. Pro. 0, 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5,
 Geo. Pro. 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048,
 6, 6.5, 7, 7.5, &c.
 4096, 8192, 16384, 32768, &c.

These progressions may again be interpolated in the same manner by new terms, and the process carried on continually, till at length every integer shall occur in the geometrical series, or a number so near to it, that the difference may be neglected without sensible error, and then the numbers in the arithmetical series corresponding to these integers may be called their logarithms.

In forming the common tables of logarithms, the progressions first assumed, were

Arith. Prog. 0, 1, 2, 3, 4, 5, 6, &c.
 Geom. Prog. 1, 10, 100, 1000, 10000, 100000, 1000000, &c.

New terms were continually interpolated, in the manner shown in the former series, until the natural numbers 1, 2, 3, 4, &c. occurred in the geometrical series; and then the numbers in the arithmetical series, corresponding to these natural ones, were taken to compose the tables of logarithms.

Logarithms may also be considered as the exponents of the power to which a given number must be raised, in order to produce all the natural numbers.

Thus, let r be any given number, and let such values be successively assigned to x as will make $r^x = a$, $r^{x'} = b$, $r^{x''} = c$, &c.; then x , x' , x'' , &c. are the logarithms of a , b , c , &c. respectively.

If $x = 0$, then $r = 1$ whatever be the value of r ; hence in every system of logarithms, the logarithm of 1 is $= 0$. Hence, also, when $x = 1$, it is obvious a will be equal to r . The constant quantity r is called the *radix* or *base* of the system, and in every system it is that number whose logarithm is 1.

Since, therefore, r may be assumed of any value greater or less than unity, it is evident that there may be innumerable systems of logarithms answering to the natural numbers; but since 10 is the *base* of our system of arithmetic, it has accordingly been assumed as the *base* of our common tables of logarithms; therefore,

Let $r = 10$ and we have $10^{-3} = \frac{1}{1000}$, $10^{-2} = \frac{1}{100}$, $10^{-1} = \frac{1}{10}$, $10^0 = 1$, $10^1 = 10$, $10^2 = 100$, $10^3 = 1000$, &c., that is, the log. of $\frac{1}{1000}$ or $\cdot 001$ is -3 , of $\frac{1}{100}$ or $\cdot 01$ is -2 , of $\frac{1}{10}$ or $\cdot 1$ is -1 , of 1 is 0 , of 10 is 1 , of 100 is 2 , of 1000 is 3 ,

&c. Hence it is evident that the logarithm of any number falling between $\cdot 001$ and $\cdot 01$ will be $-3 +$ some fraction; that of any number between $\cdot 01$ and $\cdot 1$ will be $-2 +$ some fraction; that of a number between $\cdot 1$ and 1 will be $-1 +$ some fraction; that of a number between 1 and 10 will be a proper fraction; that of a number between 10 and 100 will be $1 +$ some fraction; that of a number between 100 and 1000 will be $2 +$ some fraction, and so on. It is therefore manifest, that in this system the logarithm of any number and that of another, 10 , 100 , 1000 , &c. times greater or less will consist of the same decimal fraction, and differ only in the integral part; so that all numbers, whether they are integers, decimals, or partly integral and partly decimal, have the same positive quantity for the decimal part of their logarithm; thus,

The logarithm of 1839	is 3·264582
· · · · · 183·9	is 2·264582
· · · · · 18·39	is 1·264582
· · · · · 1·839	is 0·264582
· · · · · ·1839	is $\bar{1}$ ·264582* or 9·264582
· · · · · ·01839	is $\bar{2}$ ·264582 or 8·264582
· · · · · ·001839	is $\bar{3}$ ·264582 or 7·264582

PROPERTIES OF LOGARITHMS.

1. Let a and b be any two numbers, and let $r^x = a$ and $r^{x'} = b$; then x is the log. of a , and x' the log. of b . Now $a \times b = r^x \times r^{x'} = r^{x+x'}$; but the log. of $r^{x+x'} = x + x'$, therefore the log. of $a \times b = x + x' = \log. a + \log. b$. In like manner, it may be shown, that $\log. a \times b \times c \times \&c. =$

* When the index or *characteristic* of the logarithm is negative, the sign $-$ is generally put above it in order to distinguish it from the decimal part, which must always be considered $+$ or affirmative.

$\log. a + \log. b + \log. c + \&c.$ Hence the logarithm of the product of any number of quantities is equal to the sum of their logarithms.

2. Again, $\frac{a}{b} = \frac{r^x}{r^{x'}} = r^{x-x'}$; but the log. of $r^{x-x'} = x - x'$, therefore the log. of $\frac{a}{b} = x - x' = \log. a - \log. b$; hence the logarithm of the quotient of any two numbers is equal to the difference of the logarithm of these numbers, or the log. of a fraction $\frac{a}{b}$ is equal to the log. of the numerator, minus that of the denominator. If a is less than b , then $\log. a - \log. b$ is negative; consequently the logarithms of all proper fractions are negative.

3. Let $a = r^x$ be raised to the n th power, then $a^n = r^{xn}$; but the log. of r^{xn} is xn , therefore the log. of $a^n = xn = n$ times the log. of a . In like manner, taking the n th root of $a = r^x$, we have $a^{\frac{1}{n}} = r^{\frac{x}{n}}$; but the log. of $r^{\frac{x}{n}}$ is $\frac{x}{n}$, therefore the log. of $a^{\frac{1}{n}} = \frac{x}{n} = \frac{\log. a}{n}$; hence the logarithm of the n th power of any number is equal to its logarithm multiplied by n , and the logarithm of the n th root of any number is equal to its logarithm divided by n .

4. Let $a, na, n^2a, n^3a, \&c.$ be a series of numbers in geometrical progression, such that x is the log. of a , and y that of n ; then $r^x = a$ and $r^y = n$; and the logarithm of the numbers in the geometrical series will be $r^x, r^{x+y}, r^{x+2y}, r^{x+3y}, \&c.$ which evidently form an arithmetical progression; hence, as before shown, if a series of numbers are in geometrical progression, their logarithms are in arithmetical progression.

5. To insert m geometric means between a and y . In the equation $y = ar^{n-1}$, let $n = m+2$, then the ratio $r = \left(\frac{y}{a}\right)^{\frac{1}{m+1}}$, and $\log. r = \frac{\log. y - \log. a}{m+1}$; hence the several means are $ar, ar^2, ar^3, \&c. \dots ar^m$, and their logs. are $\log.$

$a + \log. r, \log. a + 2 \log. r, \log. a + 3 \log. r, \&c. \dots \log. a + m \log. r$. Thus, suppose it were required to insert 10 geometric means between 1 and 2; here $\log. a = 0$, and $\log. r = \frac{1}{11} \log. 2 = 0.02736636$; hence $r = 1.065041$, and the logarithms of the consecutive terms are $2 \log. r, 3 \log. r, 4 \log. r, \&c.$ The progression is therefore 1, 1.065041, 1.134312, 1.208089, 1.286665, 1.370351, 1.459480, 1.554406, 1.655506, 1.763182, 1.877862 and 2.

APPLICATION OF LOGARITHMS.

The index or integral part of the logarithm of any whole or mixed number, as has already been shown, is always *one less* than the number of integral figures of which the number consists; and in decimal fractions, the index, which is negative, is that number which points out *the distance of the first significant figure from the place of units*. Instead of negative indices, their *arithmetical complements* to 10 are often used. Thus, if there is no cipher between the decimal point and the first significant figure of the decimal, the index is $\bar{1}$ or 9; if there is one cipher between them, the index is $\bar{2}$ or 8; if two ciphers are between them it is $\bar{3}$ or 7, and so on.

The indices being thus readily found are omitted in the common logarithmic tables, and the decimal part only of the logarithms inserted.

PROBLEM I. To find the logarithm of any given number from the table.

I. If the given number is not greater than 100, the logarithm with its index prefixed will be found in the first page of the table immediately opposite the number; thus the log. of 65 is 1.812913, and that of 88 is 1.944483.

II. If the number consists of three figures, it will be found in the margin on the left-hand side of the page, and the decimal part of its log. immediately opposite in the column under 0; thus the log. of 536 is 2.729165, and that of 760 is 2.880814.

III. If the number consists of four figures, the first three will be found in the margin on the left-hand side of the page, and immediately opposite, and under the fourth figure found

at the top of the page will be got the decimal part of the logarithm ; thus the log. of 7846 is 3·894648, and that of 37·56 is 1·574726.

IV. If the given number consists of more than four figures, find the logarithm of the first four figures as before directed ; multiply the difference between this logarithm and the next higher in the table by the remaining figures of the given number, and cut off as many figures from the product as are in the multiplier, the remaining figures added to the logarithm of the first four figures will give the logarithm required.

NOTE. The mean difference given under D in the right-hand column may be used, except in the first three pages of the table, where they vary rapidly. To find the logarithm of 476·384. Opposite to the number 476 in the margin, and under 3 at the top is ·677881, the difference in the column D on the right hand of the page is 91, which multiplied by 84 and two figures cut off, gives 76 to be added to ·677881, and since there are three integral figures the index is 2 ; the logarithm of 476·384 is therefore 2·677957. Again, to find the logarithm of 1056·472. The log. of the first four figures is ·023664, the difference between this and the next higher in the table is 411 (that in the column marked D being 412). Now 411×472 , and three figures cut off, gives 194, which added to the log. of the first four figures, and the proper index prefixed, we have 3·023858 as the required logarithm. If the number had been 105647 2, the decimal part of the logarithm would have been the same, but the index would have been 5.

As examples for practice, find the logarithm of

4719	.	.	.	Ans. 3·673850
47218	.	.	.	Ans. 4·674108
210·394	.	.	.	Ans. 2·323034
7218·65	.	.	.	Ans. 3·858456
21056·3	.	.	.	Ans. 4·323382
714219·5	.	.	.	Ans. 5·853939
·0009146	.	.	.	Ans. 4·961231 or 6·961231

PROBLEM II. To find the number corresponding to a given logarithm.

If the given logarithm be found in the table, the first three figures of the number will be found on the same line in the left-hand column of the page, and the fourth at the top or bottom of the column in which the logarithm is found. But

if the logarithm be not found exactly in the table, take the number answering the next less; subtract this log. from the given one, and also from the next greater in the table; and annexing ciphers to the first remainder, divide it by the other, or by the mean difference found in the column marked D, to find the fifth, sixth, &c. figures of the number. The integral places must always be one more than the units in the index of the given logarithm, and the rest decimals; thus

To find the number answering to the logarithm 3.721906. This log. is not found in the table, but the next less is .721893, and the number answering to this is 5271; now the difference between the given log. and that next less found in the table is 13, and the difference between that found in the table, and the next greater is 82 (that in the column marked D is also 82); hence $1300 \div 82 = 18$; the number, therefore, corresponding to log. 3.721906 is 5271.18.

Find the numbers answering the following logarithms:

Log. 2.754096	. . .	Ans. 567.67
Log. 4.069375	. . .	Ans. 11732.08
Log. 3.721986	. . .	Ans. 5272.13
Log. 2.364875	. . .	Ans. .0231672
Log. 4.300847	. . .	Ans. .000199915
Log. 1.219634	. . .	Ans. .1658187

PROBLEM III. To find the arithmetical complement of a logarithm.

Subtract the logarithm from 10, an integer, or subtract the right-hand figure from 10, and all the rest from 9: thus the arithmetical complement of 2.730459 is 7.269541, and of 3.826464 is 12.173536.

PROBLEM IV. To perform multiplication by logarithms.

Add the logarithms of the factors, the sum is the logarithm of the product; thus,

To multiply 7825 by 873, we have

$$\text{Log. } 7825 = 3.893484$$

$$\text{log. } 873 = 2.941014$$

$$\text{log. } 6831218.8 = 6.834498 \text{ their sum.}$$

The correct product is 6831225, or 6·2 greater than that found by the logarithms; but when there are various operations the final error is scarcely appreciable as the slight inaccuracy of one operation generally balances that of another.

NOTE. A negative index must be subtracted when the logarithm is added, and added when the logarithm is subtracted; thus,

To multiply 786 by ·0073

$$\begin{array}{rcl} \text{Log. 786} & = & 2\cdot895423 \text{ or } 2\cdot895423 \\ \text{log. } \cdot0073 & = & \overline{3\cdot863323} \quad \overline{7\cdot863323} \\ \text{log. } 5\cdot7378 & = & \overline{0\cdot758746} \quad \overline{0\cdot758746} \end{array}$$

NOTE.—When the positive index is used, in adding, we reject 10 from the index, but in subtracting, we borrow 10.

Multiply 78·36 by 8·5	Ans. 666·06
Multiply 210·4 by ·00372	Ans. ·7826875
Multiply 486·95 by 2·0087	Ans. 978·1364
Multiply 21896 by 274·35	Ans. 6007166·7

PROBLEM V. To divide one number by another.

Subtract the log. of the divisor from that of the dividend, the remainder is the log. of the quotient; thus,

To divide 78634 by 27, we have

$$\begin{array}{rcl} \text{Log. 78634} & = & 4\cdot895610 \\ \text{log. } 27 & = & \overline{1\cdot431364} \\ \text{log. } 2912\cdot37 & = & \overline{3\cdot464246} \text{ difference.} \end{array}$$

The quotient is true to the last place of decimals; again,

To divide 7856 by ·0053, we have

$$\begin{array}{rcl} \text{Log. 7856} & = & 3\cdot895201 \text{ or } 3\cdot895201 \\ \text{log. } \cdot0053 & = & \overline{3\cdot724276} \text{ or } \overline{7\cdot724276} \\ \text{log. } 1482263 & = & \overline{6\cdot170925} \quad \overline{6\cdot170925} \end{array}$$

Divide 274·15 by 3·5	Ans. 78·3285
Divide 48160 by 27·6	Ans. 1744·928
Divide 57·486 by 389·5	Ans. ·147589
Divide 2816·4 by ·0038	Ans. 741158

PROBLEM VI. To work a proportion by logarithms.

From the sum of the logs. of the second and third terms take the log. of the first, the remainder is the log. of the answer : or

Add together the arithmetical complement of the log. of the first term and the logs. of the second and third terms, the sum is the log. of the answer ; thus,

Let the proportion be $27 : 45 :: 63$, then

$$\text{Log. } 45 = 1.653213 \quad \text{or log. } 45 = 1.653213$$

$$\text{log. } 63 = 1.799341 \quad \text{log. } 63 = 1.799341$$

$$\text{Sum, } 3.452554 \text{ ar. co. log. } 27 = 8.568636$$

$$\text{log. } 27 = 1.431364 \quad \text{log. } 105 = 2.021190$$

$$\text{log. } 105 = 2.021190 \text{ diff.}$$

If 12 men perform a piece of work in 16 days, how many will do it in 24 days? Ans. 8 men.

If 36 acres of land are rented for £84, how many may be rented for £112? Ans. 48 acres.

If 12 horses plough 32 acres of land in 6 days, working 10 hours a-day, how many acres will 16 horses plough in 48 days, working 8 hours a-day? Ans. $271\frac{1}{3}$.

How many men must be employed to reap a harvest in 21 days of 9 hours each, which 63 men can accomplish in 28 days of 12 hours each? Ans. 112 men.

NOTE. From these exercises, it will readily be perceived, how questions in Partnership, Simple Interest, Discount, Barter, Exchange, and all other varieties of Proportion may be performed.

PROBLEM VII. To involve a number by logarithms.

Multiply the log. of the given number by the name of the power ; the product is the log. of the power : thus,

To involve 27 and .005 to the 3d power.

$$\text{Log. } 27 \quad = 1.431364 \text{ log.} \quad .005 = \bar{3}.698970 \text{ or } 7.698970$$

$$\text{3d Power, } 19683 = 4.294092 \quad .000000125 = \bar{7}.096910 \quad 3.096910$$

NOTE. After multiplying the negative index, the carriage from the decimal part of the logarithm must be subtracted from the product. If the positive index is used, 10 times the name of the power lessened by one, must be taken from the product.

Involve $\cdot 0437$ to the 4th power. Ans. $\cdot 0000036469$
 Involve 32 to the 3d power. Ans. 32768
 Involve $\cdot 009$ to the 3d power. Ans. $\cdot 000000729$
 Involve 2756 to the 2d power. Ans. $7595526\cdot 3$ very
 nearly true, the correct answer being 7595536 .

PROBLEM VIII. To find any root of a number by logarithms.

Divide the logarithm of the number by the exponent of the root ; the quotient is the logarithm of the root.

NOTE. If the given number is a decimal, and the positive index used, prefix the name of the root lessened by *one* to the index before dividing. If the negative index is used, add to it the least number that will make the sum divisible by the name of the root ; the quotient is the index of the root ; but in dividing the decimal part of the logarithm, the number added to the index must be considered as the index ; thus,—

To find the 3d root of 19683, and of $\cdot 000000125$.

Log. 19683 = $3)4\cdot 294092$ log. $\cdot 000000125$ $3)\bar{7}\cdot 096910$ or $3\cdot 096910$

3d root, 27 = $1\cdot 431364$ 3d root, $\cdot 005$ = $3\cdot 698970$ or $7\cdot 698970$

Find the 4th root of $\cdot 00130321$ Ans. $\cdot 19$

Find the 3d root of 9261 Ans. 21

Find the 4th root of 7 Ans. $1\cdot 62657$

Find the 3d root of $\cdot 041063625$ Ans. $\cdot 345$

PROBLEM IX. The principal, rate, time, and amount at compound interest, any three being given, to find the others.

Denoting each by its initial letter, and putting R for the amount of £1 for a year, we have the general formula $R^t \times p = a$, whence to find the amount :

Multiply the logarithm of the amount of £1 for a year by the time, and to the product add the logarithm of the principal, the sum is the logarithm of the amount ; thus,

To find the amount of £475 for three years, at 4 per cent. compound interest, we have the amount of £1 for one year

= $1\cdot 04$ log. $0\cdot 017033$

3

$0\cdot 051099$

Principal, £475 . . log. = $2\cdot 676694$

Amount, £534 \cdot 31 . log. = $2\cdot 727793$

Interest, £ 59 \cdot 31

In what time will £475 amount to £534·31 at 4 per cent. per annum, compound interest; here the formula becomes $a \div p = R^t$; hence

$$\begin{array}{rcl} a = 534\cdot31 & \log. & 2\cdot727793 \\ p = 475 & \log. & 2\cdot676694 \\ R = 1\cdot04 \text{ its } \log. & \cdot017033 & 0\cdot051099 \text{ (3 years.} \\ & & \underline{0\cdot051099} \end{array}$$

$$\begin{array}{rcl} \text{Or } \log. \cdot051099 & = & 8\cdot708413 \\ \log. \cdot017033 & = & 8\cdot231292 \\ \text{Years } 3 \log. & = & \underline{0\cdot477121} \end{array}$$

What principal will amount to £534·31 in three years at 4 per cent. per annum, compound interest?

Here the formula is $p = \frac{a}{R^t}$; hence

$$\begin{array}{rcl} a = £534\cdot31 \log. & = & 2\cdot727793 \\ R = 1\cdot04 \log. \times 3 & = & \underline{0\cdot051099} \\ p = £475 \log. & = & \underline{2\cdot676694} \end{array}$$

At what rate per cent. per annum will £475 amount to £534·31 in three years, compound interest?

Here the formula is $R = \sqrt[t]{\frac{a}{p}}$

$$\begin{array}{rcl} a = £534\cdot31 \log. & = & 2\cdot727793 \\ p = £475 \log. & = & \underline{2\cdot676694} \\ t = 3 & & 3)0\cdot051099 \\ R = 1\cdot04 \log. & = & \underline{0\cdot017033} \end{array}$$

Whence the rate is 4 per cent. per annum.

TABLE FOR REDUCING COMMON TO HYPERBOLIC LOGARITHMS
AND THE CONVERSE.

Page 17.

The following examples will show the method of using this table.

1. What is the hyperbolic logarithm of 4863, its common logarithm being 3·6869043.

Common Log.	Hyperbolic Log.
3·6	8·2893063
86	1980223
90	20723
43	99
<hr/> 3·6869043	<hr/> Ans. 8·4894108

2. What is the common logarithm answering to the hyperbolic logarithm 8·4894108.

Given hyperbolic logarithm	8·4894108
3·6	8·2893063
	<hr/> 2001045
86	1980223
	<hr/> 20822
90	20723
	<hr/> 99
43	99
<hr/> 3·6869043	

3·6869043 common log. required.

TABLE OF THE GEOGRAPHICAL MILES IN A DEGREE OF LONGITUDE AT EVERY DEGREE OF LATITUDE ON THE TERRESTRIAL SPHEROID.

Page 17.

This table is calculated by WILLIAM GALBRAITH, A. M., Teacher of Mathematics, Edinburgh, assuming an ellipticity of $\frac{1}{300}$, which is extremely near the truth. It will be found very useful on many occasions to astronomers, navigators, and surveyors of large tracts of country. The number of miles in a degree of longitude at any degree of latitude is found by inspection, and for minutes and seconds proportional parts may be taken, thus:

To find the length of a degree of longitude in latitude $29^{\circ} 25' 45''$, or $30^{\circ} - (34' 15'')$

Length at 30°	52·004 miles.
Proportional part for $34'$	·291
Proportional part for $15''$	2
	<hr/> Ans. 52·297 miles.

TABLE OF THE VELOCITY AND FORCE OF THE WIND.

Page 17.

In this table the force of the wind has been calculated upon the usual theory, that is, in the ratio of the square of the velocity. The experiments of Dr HURTON indicate a higher ratio, namely, that of the 2.04 power, and this ratio gradually increases, till, at the velocity of 2000 feet per second, it becomes the 2.1 power of the velocity. The table will, however, be sufficiently accurate for common purposes.

TRIGONOMETRICAL LINES.

DEFINITIONS.

1. The SINE BG of an arc AB is a straight line drawn from B, one of its extremities, perpendicular to the diameter AE, which passes through the other.

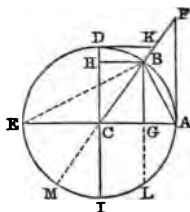
2. The VERSINE AG of an arc AB is that portion of the diameter AE upon which the sine is perpendicular, intercepted between the sine and the arc.

3. The TANGENT AF of an arc AB is a perpendicular to the radius CA at one extremity of the arc, and meets at F the diameter MB, which passes through the other extremity at B.

4. The SECANT CF of an arc AB is a straight line drawn from C the centre, to F the farthest extremity of the tangent.

5. The sine, versine, tangent, and secant of an arc AB are called the sine, versine, tangent, and secant of the angle ACB , measured by that arc, to the radius AC .

6. The COMPLEMENT of an arc $\overset{\frown}{AB}$, or angle $\angle ACB$, is what it wants of a quadrant or 90° . Thus $\overset{\frown}{BD}$ or $\angle BCD$ is the complement of $\overset{\frown}{AB}$ or $\angle ACB$.



7. The **SUPPLEMENT** of an arc AB, or of an angle ACB, is what it wants of a semicircle or 180° . Thus BE or AM is the supplement of AB, and BCE or ACM the supplement of ACB.

An arc or angle, and its supplement, have the same sine, tangent, and secant, for BG is the sine of BE or BCE, AF the tangent of AM or ACM, and CF the secant of AM or ACM.

The versine EG of BCE (or the supplemental versine of ACB), together with AG the versine of ACB, is equal to the diameter AE.

8. The **EXPLEMENT** of an arc AB or of an angle ACB, is what it wants of the whole circumference, or of four right angles. Thus BDEMLA is the explement of AB or of ACB.

9. The sine, versine, tangent, and secant of the complement of an arc or angle, are called the cosine, coversine, cotangent, and cosecant of the arc or angle. Thus BH or CG is the cosine of AB or ACB, DH is its coversine, DK its cotangent, and CK its cosecant.

The cosine CG, together with the versine AG, is equal to the radius AC.

The radius is equal to the sine or versine of 90° , and to the tangent or cotangent of 45° .

NOTE. We generally write sin. for sine, cos. for cosine, tan. for tangent, sec. for secant, cot. for cotangent, cosec. for cosecant, ver. for versine, cov. for coversine, suv. for supplemental versine, cho. for chord, R. or rad. for radius, and D. or dia. for diameter.

OF THE SIGNS OF THE TRIGONOMETRICAL LINES.

In analytical trigonometry, and its application to astronomy, it is necessary to attend to the changes which the several quantities undergo in the different quadrants of the circle.

Geometrical quantities, when expressed analytically, are estimated from some given point or line, and are considered as + or — according as they lie on the one or on the other side of that point or line.

The sines are estimated from the diameter EA, and the cosines from the centre C; and if we consider the sines as *positive* when they lie above the diameter, and the cosines when they lie on the right-hand side of the centre, it is obvious that in the first quadrant AD the sines and cosines are both *positive*. In the second quadrant DE, the sines lying still above the diameter are *positive*; but the cosines, having changed their position in regard to the centre, are now *negative*. The sines changing their position in the third quadrant EI are now set off below the diameter, and the cosines remaining as in the second quadrant, they are therefore both *negative*. And in the fourth quadrant the sines still lying below the diameter are *negative*, while the cosines, having resumed their original position in regard to the centre, are *positive*.

The signs of the other quantities may be easily determined, for since $\tan. = \frac{\sin.}{\cos.}$, it follows, that when the signs of the sine and cos. are alike, that of the tan. is positive, and when unlike, the sign of the tan. is negative.

The following table exhibits the mutations of the signs of the different quantities for each quadrant of the circle.

Quadrants.	Sin.	Cos.	Tan.	Cot.	Sec.	Cosec.	Vers.	Cov.
1.	+	+	+	+	+	+	+	+
2.	+	—	—	—	—	+	+	+
3.	—	—	+	+	—	—	+	+
4.	—	+	—	—	+	—	+	+

NOTE 1. The signs of the sine and cosec., of the cos. and sec., of the tan. and cot., are respectively *alike*; and the signs of the ver. and cov. are always *positive*, the former being set off from A in the same direction, and the latter from E in the contrary direction.

NOTE 2. The sines, cosines, &c. may be considered not only as belonging to arcs less than four quadrants, but also to those arcs increased by any number of complete circumferences.

CONSTRUCTION OF A TABLE OF SINES, COSINES, &c.

Various methods have been employed in computing the numerical values of the sines, cosines, &c. The following, however, are the most simple.

FIRST METHOD. If x be any arc of a circle whose radius is unity, it has been shown by Newton, that

$$\text{Sin. } x = x - \frac{x^3}{1.2.3} + \frac{x^5}{1.2.3.4.5} - \frac{x^7}{1.2.3.4.5.6.7} + \&c., \text{ and}$$

$$\text{Cos. } x = 1 - \frac{x^2}{1.2} + \frac{x^4}{1.2.3.4} - \frac{x^6}{1.2.3.4.5.6} + \&c.$$

Now, by means of these series, and the ratio between the diameter and circumference of the circle, the sines and cosines of any arc may be easily found.

When the radius is unity, half the circumference is 3.141592653589793 , &c., and as there are 180° or $10800'$ in a semicircle, it is obvious that, if we divide the former by the latter, we will obtain the length of an arc of 1 minute = $.00029088821$; whence, if the arc is 1 minute,

$$\begin{aligned} x &= .00029088821 \\ -\frac{1}{6}x^3 &= -.0000000000004 \\ \therefore \text{Sin. } x &= .0002908882 = \text{the sine of 1 minute.} \end{aligned}$$

Again from 1.0000000000

$$\text{Take } \frac{1}{2}x^2 = 0.0000000423$$

$$\therefore \text{Cos. } x = .9999999577 = \text{the cosine of 1 minute.}$$

To find the sine and cosine of an arc of 5° .

$$\begin{aligned} \text{Here } \frac{5 \times 3.14159265}{180} &= .08726646 = x = \text{the length of an} \\ \text{arc of } 5^\circ; \text{ hence } x &= 0.08726646 \\ -\frac{1}{6}x^3 &= -.00011076 \\ +\frac{1}{120}x^5 &= +0.00000004 \\ \therefore \text{Sin. } x &= 0.08715574 = \text{the sine of 5 degrees.} \end{aligned}$$

And for the cosine 1.00000000

$$\begin{aligned} -\frac{1}{2}x^2 &= -.00380771 \\ +\frac{1}{24}x^4 &= +0.00000241 \\ \therefore \text{Cos. } x &= 0.99619470 = \text{the cosine of 5 degrees.} \end{aligned}$$

This method answers remarkably well for the sines and cosines near the beginning and end of the quadrant, for when the arc does not exceed $10'$, the first two terms of the series *give the sine and cosine true to 15 places*; and when it does

not exceed 1° , the first three terms give them true to the same number of places, but the nearer the arc is to 45° , the more slowly do these series converge, and therefore the greater are the number of terms that must be employed in the calculation.

NOTE. It is necessary to compute the sines only, as the cosines are more easily found from the equation; $\cos. = \sqrt{1 - \sin.^2}$.

SECOND METHOD. It may be shown that $\sin. 2a = 2 \sin. a \cos. a$; whence, after computing the sine and cos. of $1'$ by the last method, and substituting $1'$ for a , we obtain the sine of $2'$: thus,

$$\sin. 2' = 2 \sin. 1' \cos. 1'.$$

And for the sine of $3'$ and upwards we employ the formula.

$$\sin. (a+b) + \sin. (a-b) = 2 \sin. a \cos. b,$$

$$\text{Or } \sin. (a+b) = 2 \sin. a \cos. b - \sin. (a-b),$$

where if a is taken successively = $2', 3', 4', \&c.$, and $b = 1'$, we have

$$\sin. 3' = 2 \sin. 2' \cos. 1' - \sin. 1'$$

$$\sin. 4' = 2 \sin. 3' \cos. 1' - \sin. 2'$$

$$\sin. 5' = 2 \sin. 4' \cos. 1' - \sin. 3'$$

$$\&c. \qquad \&c. \qquad \&c.$$

In like manner, for the cosines, we have the formula

$$\cos. (a+b) + \cos. (a-b) = 2 \cos. a \cos. b.$$

$$\text{or } \cos. (a+b) = 2 \cos. a \cos. b - \cos. (a-b).$$

and taking a successively = $2', 3', 4', \&c.$, and $b = 1'$, we have

$$\cos. 3' = 2 \cos. 2' \cos. 1' - \cos. 1'.$$

$$\cos. 4' = 2 \cos. 3' \cos. 1' - \cos. 2'.$$

$$\cos. 5' = 2 \cos. 4' \cos. 1' - \cos. 3'.$$

$$\&c. \qquad \&c. \qquad \&c.$$

In this manner, the sines and cosines may be computed as far as 30° , when the remainder of the table may be found from the following formulæ by subtraction only.

$$\sin. a \cos. b = \frac{1}{2} \sin. (a+b) + \frac{1}{2} \sin. (a-b).$$

$$\sin. a \sin. b = \frac{1}{2} \cos. (a-b) - \frac{1}{2} \cos. (a+b).$$

Where if a is taken $= 30^\circ$, then $\sin. a = \sin. 30^\circ = \frac{1}{2}$;
whence

$$\frac{1}{2} \text{Cos. } b = \frac{1}{2} \sin. (30^\circ + b) + \frac{1}{2} \sin. (30^\circ - b).$$

$$\frac{1}{2} \text{Sin. } b = \frac{1}{2} \cos. (30^\circ - b) - \frac{1}{2} \cos. (30^\circ + b).$$

Multiply these expressions by 2, and transpose ; we have

$$\text{Sin. } (30^\circ + b) = \cos. b - \sin. (30^\circ - b).$$

$$\text{Cos. } (30^\circ + b) = \cos. (30^\circ - b) - \sin. b.$$

Now if b is taken successively $= 1', 2', 3', 4', \&c.$ we have
for the sines

$$\text{Sin. } 30^\circ 1' = \cos. 1' - \sin. 29^\circ 59'$$

$$\text{Sin. } 30^\circ 2' = \cos. 2' - \sin. 29^\circ 58'$$

$$\text{Sin. } 30^\circ 3' = \cos. 3' - \sin. 29^\circ 57'$$

$$\&c. \qquad \&c. \qquad \&c.$$

And for the cosines

$$\text{Cos. } 30^\circ 1' = \cos. 29^\circ 59' - \sin. 1'$$

$$\text{Cos. } 30^\circ 2' = \cos. 29^\circ 58' - \sin. 2'$$

$$\text{Cos. } 30^\circ 3' = \cos. 29^\circ 57' - \sin. 3'$$

$$\&c. \qquad \&c. \qquad \&c.$$

By these two methods the sines and cosines may be computed as far as 45° ; and it is obvious, from the definitions, that the sines and cosines will also be found from 45° to 90° for $\sin. 50^\circ = \cos. 40^\circ$, and $\sin. 60^\circ = \cos. 30^\circ$, &c.

Having thus completed the Table of Sines and Cosines, let us again refer to the figure in page 19, in which the triangles CGB, CAF, and CDK, are evidently similar ; we have therefore

CG : GB :: CA : AF, or the cosine of an arc is to its sine

as the rad. to the tan. ; therefore $\tan. = \frac{R \times \sin.}{\text{Cos.}} = \frac{\text{Sin.}}{\text{Cos.}}$ if
radius $= 1$.

Again, CG : CB or CA :: CA : CF, or the radius is a mean proportional between the cosine of an arc and its secant ;

whence $\sec. = \frac{R^2}{\text{Cos.}} = \frac{1}{\text{Cos.}}$, if radius $= 1$.

From these two formulæ, then, the tangents and secants may be readily computed, when the cotangents and cosecants will also be known.

The versines are $= 1 \mp \cos.$, according as the arc is greater or less than 90° , and the coversines are the complements of the versines to 1.

The sines, cosines, &c. of which we have shown the methods of computing, are called *natural* sines, cosines, &c. and when these are arranged in a table from $1'$ up to 90° , they form what is called the *Trigonometrical Canon*.

The logarithmic tables of sines, cosines, &c. are formed by taking the logarithms of all the natural sines, cosines, &c., and adding 10 to their indices, as the logarithmic sines, cosines, &c. are supposed to be computed to the radius 10,000,000,000 in order that the smallest arc to be used in calculation may not have a negative index.

TABLE OF THE ANGLES WHICH EVERY POINT AND QUARTER-POINT OF THE COMPASS MAKES WITH THE MERIDIAN.

Page 18.

This table is useful for reducing the points of the compass to degrees, &c. and conversely.

TABLE OF LOGARITHMIC SINES, TANGENTS, SECANTS, &c., TO EVERY POINT AND QUARTER-POINT OF THE COMPASS.

Page 18.

This table is used by navigators when the logarithmic sine, tangent, &c. of a ship's course is required to points of the compass, thereby saving the trouble of reducing them to degrees, minutes, &c. by the preceding table. The method of using it will be obvious from the explanation of the following table.

TABLE OF LOGARITHMIC SINES, COSINES, TANGENTS, AND COTANGENTS.

Page 19 *et seq.*

The table has the degrees at the top and the minutes on the left-hand side of the page when the degrees are less than 45 ; but when 45° and upwards, the degrees are at the bottom and the minutes on the right-hand side of the page.

PROBLEM I. To find the sine, cosine, &c., answering to any given arc expressed in degrees and minutes.

If the number of degrees is less than 45° , find the number at the top of the page, and the minutes in the left-hand column; opposite to the minutes, and under the word sine, cosine, &c. is the logarithm required. If the degrees are 45° or upwards, find the number at the bottom of the page, and opposite the number of minutes in the right-hand column, and under the proper title, will be found the logarithm required.

To find the log. sine of $35^\circ 45'$.

Under the word sine in the page marked 35° at the top, and opposite $45'$ in the left-hand column, is found 9.766598, the log. sine required.

To find the log. tan. of $57^\circ 16'$.

Above the word tang. in the page marked 57° at the bottom, and opposite $16'$ in the right-hand column, is found 10.191917 the log. tan. required.

NOTE 1. If the given arc exceeds 90° , and is less than 180° , take the sine, cosine, &c. of its supplement, or, which is simpler, to find the *sine* of an arc above 90° , reject 90° and take the *cosine* of the remainder; to find the *cosine* of an arc above 90° , reject 90° and take the *sine* of the remainder. The same method may be followed for tangents and secants; cotangents and cosecants. Thus log. sine of $108^\circ =$ log. cosine of 18° .

NOTE 2. If the arc is between 180° and 270° diminish it by 180° , and take the log. sine, cosine, &c. of the remainder. Thus log. sin. $210^\circ =$ log. sin. 30° .

NOTE 3. If the arc is between 270° and 360° use its explement to 360° , or for the *sine* take the *cosine* of its excess above 270° , and for the cosine take the sine of the excess above 270° . Thus log. sine $290^\circ =$ log. sine 70° , or log. cosine 20° .

PROBLEM II. To find the log. sine, tangent, &c. of any arc expressed in degrees, minutes, and seconds.

Find the log. sine, tangent, &c. corresponding to the given number of degrees and minutes as directed in last problem, and take the difference between it and that answering to the next greater minute; multiply this difference by the given number of seconds, and divide the product by 60, then add the quotient to the log. sine, tangent, &c., but subtract it from the log. cos., log. cot. &c. of the given degrees and minutes, and the sum or difference will be the log. required.

To find the log. sine of $34^{\circ} 25' 40''$

$$\begin{array}{rcl}
 \text{log. sine of } 34^{\circ} 25' & = & 9.752208 \\
 \text{log. sine of } 34^{\circ} 26' & & 9.752392 \\
 \hline
 \text{Difference,} & & 184 \\
 \text{Seconds,} & & 40 \\
 \hline
 & & 60 \overline{)7360} \\
 & & 123 \text{ nearly.}
 \end{array}$$

$$\begin{array}{rcl}
 \text{Log. sine of } 34^{\circ} 25' & = & 9.752208 \\
 \text{Proportional part for } 40'' & & 123 \\
 \hline
 \text{Log. sine of } 34^{\circ} 25' 40'' & = & 9.752331
 \end{array}$$

To find the log. cos. of $24^{\circ} 16' 36''$

$$\begin{array}{rcl}
 \text{Log. cos. } 24^{\circ} 16' & = & 9.959825 \\
 \text{Log. cos. } 24^{\circ} 17' & = & 9.959768 \\
 \hline
 \text{Difference,} & & 57 \\
 \text{Seconds,} & & 36 \\
 \hline
 & & 60 \overline{)2052} \\
 & & 34 \text{ nearly.}
 \end{array}$$

$$\begin{array}{rcl}
 \text{Log. cos. } 24^{\circ} 16' & = & 9.959825 \\
 \text{Proportional part for } 36'' & = & 34 \\
 \hline
 \text{Log. cos. } 24^{\circ} 16' 36'' & = & 9.959791
 \end{array}$$

To find the log. secant of $20^{\circ} 20' 35''$

$$\begin{array}{rcl}
 \text{Log. cos. of } 20^{\circ} 20' & = & 9.972058 \\
 \text{Log. cos. of } 20^{\circ} 21' & = & 9.972011 \\
 \hline
 \text{Difference,} & & 47 \\
 \text{Seconds,} & & 35 \\
 \hline
 & & 60 \overline{)1645} \\
 & & 27 \text{ nearly.}
 \end{array}$$

$$\begin{array}{rcl}
 \text{Log. cos. } 20^{\circ} 20' & = & 9.972058 \\
 \text{Proportional part for } 35'' & = & 27 \\
 \hline
 \text{Log. cos. } 20^{\circ} 20' 35'' & & 9.972031 \\
 \text{(See Rule, page 41, Tables), } & & 20.000000 \\
 \hline
 \text{Log. sec. of } 20^{\circ} 20' 35'' & = & 10.027969
 \end{array}$$

To find the log. cosecant of $31^{\circ} 25' 20''$

$$\text{Log. sine } 31^{\circ} 25' = 9.717053$$

$$\text{Log. sine } 31^{\circ} 26' = 9.717259$$

$$\text{Difference,} \quad 206$$

$$\text{Seconds,} \quad 20$$

$$6,0)412,0$$

Proportional part for $20''$ 69 nearly.

$$\text{Log. sine } 31^{\circ} 25' = 9.717053$$

$$\text{Log. sine } 31^{\circ} 25' 20'' = 9.717122$$

$$20.000000$$

$$\text{Log. cosec. } 31^{\circ} 25' 20'' = 10.282878$$

To find the log. versine of $24^{\circ} 16' 40''$.

Half the arc $12^{\circ} 8' 20''$.

$$\text{Log. sine } 12^{\circ} 8' = 9.322607$$

$$\text{Log. sine } 12^{\circ} 9' = 9.323194$$

$$\text{Difference,} \quad 587$$

$$\text{Seconds,} \quad 20$$

$$6,0)1174,0$$

Proportional parts for $20'' = 196$ nearly.

$$\text{Log. sine } 12^{\circ} 8' = 9.322607$$

$$\text{Log. sine } 12^{\circ} 8' 20'' = 9.322803$$

$$2$$

$$18.645606$$

$$0.301030$$

$$\text{Log. versine of } 24^{\circ} 16' 40'' = 8.946636$$

$$\text{Find the sine of } 26^{\circ} 28' 32'' \quad \text{Ans. } 9.649155$$

$$\text{Find the cos. of } 32^{\circ} 18' 26'' \quad \text{Ans. } 9.926956$$

$$\text{Find the tan. of } 47^{\circ} 18' 20'' \quad \text{Ans. } 10.034989$$

Find the cot.	of $36^{\circ} 29' 17''$	Ans. 10·130980
Find the sine	of $136^{\circ} 15' 24''$	Ans. 9·839747
Find the cos.	of $284^{\circ} 16' 12''$	Ans. 9·391713
Find the tan.	of $220^{\circ} 15' 10''$	Ans. 9·927702
Find the cot.	of $108^{\circ} 16' 20''$	Ans. 9·518751
Find the sec.	of $84^{\circ} 17' 12''$	Ans. 10·001933
Find the cosec.	of $56^{\circ} 29' 15''$	Ans. 10·078956
Find the vers.	of $40^{\circ} 28' 50''$	Ans. 9·379076
Find the cov.	of $32^{\circ} 18' 30''$	Ans. 9·667942

PROBLEM III. To find the log. sine, tan., &c. of an arc less than three degrees, and also of one greater than 87° .

1. To find the sine.

Add the constant number 4·685575 to the log. of the arc in seconds, and subtract one-third of the arithmetical complement of the log. cosine from the sum, the remainder will give the log. sine of the given arc.

2. To find the tangent.

To the constant number 4·685575 add the log. of the arc in seconds, and also $\frac{2}{3}$ of the arithmetical complement of the cosine; the sum is the log. tan. of the given arc.

NOTE. For the log. cos. and cot. take the log. sin. and tan. of the complement of the given arc.

To find the log. sine of $1^{\circ} 2' 12\cdot5''$.

Constant number,	4·685575
Log. of 3732·5"	= 3·572000
	<hr/> 8·257575
$\frac{1}{3}$ Ar. co. cos. $1^{\circ} 2' 12\cdot5''$	= 0·000024
Log. sine of $1^{\circ} 2' 12\cdot5''$	= 8·257551

To find the log. tan. of $0^{\circ} 24' 15\cdot3''$.

Constant number,	4·685575
Log. of 1455·3"	= 3·162952
$\frac{2}{3}$ Ar. co. cos. $24' 15\cdot3''$	= 0·000007
Log. tan. $0^{\circ} 24' 15\cdot3''$	= 7·848534

PROBLEM IV. To find the degrees and minutes answering to any log. sine, tangent, &c.

In the column headed sine, tangent, &c. find the nearest one to that given, and take the degrees from the top or bottom of the page according as the quantity is found in a column with the proper title at the top or bottom, and the minutes are found in the same horizontal line on the left-hand side of the page when the degrees are at the top, otherwise on the right-hand side of the page.

To find the degrees and minutes answering to log. sine 9.448618. In the column marked sine at the top, under 16° and opposite 19' on the left-hand side is found the log. sine 9.448623, differing from that given only by 5 in the right-hand figure. Hence the degrees and minutes answering to log. sine 9.448618 are 16° 19', and so on for any other given log.

PROBLEM V. To find the degrees, minutes, and seconds, &c. answering to any log. sine, tangent, &c.

Find, as in last problem, the degrees and minutes answering to the next less logarithm in the proper column, and subtract this log. from the given one, multiply the remainder by 60, and divide the product by the difference between the log. found in the table and that corresponding to the next greater minute, the quotient will be the seconds to be added to the arc when the log. sine or log. tan. is given, but to be subtracted from it when the log. cos. or log. cot. is given.

NOTE. The log. sine, log. tan., &c. of an arc is also the log. sine log. tan., &c. of the supplement of that arc.

To find the degrees, minutes, and seconds answering log. tan. 9.538764.

Given log. tan.	9.538764	
Log. tan. 19° 4' =	9.538611	9.538611
	153	Log. tan. 19° 5' = 9.539020
		409

Then $153 \times 60 \div 409 = 9180 \div 409 = 22.4''$. Hence 9.538764 is the log. tan. of 19° 4' 22.4''.

To find the degrees, minutes, and seconds answering to log. cos. 9.568421.

$$\begin{array}{r}
 \text{Given log. cos.} \quad 9.568421 \\
 \text{Log. cos. } 68^\circ 17' = 9.568222 \quad 9.568222 \\
 \hline
 199 \text{ Log. cos. } 68^\circ 16' = 9.568539 \\
 60 \quad \hline
 317 \\
 317)11940(37.7'' \\
 \underline{951} \\
 2430 \\
 \underline{2219} \\
 2110
 \end{array}$$

\therefore 9.568421 is the log. cos. answering to $68^\circ 17' - 37.7'' = 68^\circ 16' 22.3''$.

NOTE. Instead of taking the log. cos. or log. cot. next less, we may take that next greater, when the seconds, found as before, must be added to the arc. Thus,

$$\begin{array}{r}
 \text{Log. cos. } 68^\circ 16' = 9.568539 \quad = 9.568539 \\
 \text{Given log. cos.} = 9.568421 \\
 \hline
 118 \\
 60 \text{ Log. cos. } 68^\circ 17' = 9.568222 \\
 \hline
 317)7080 \quad \hline
 317 \\
 22.3''
 \end{array}$$

Hence $68^\circ 16' 22.3''$ the arc as before.

Find the arcs answering to

Log. sine 9.574486	Ans. $22^\circ 2' 47.7''$
Log. cos. 9.534876	Ans. $69^\circ 57' 37.3''$
Log. tan. 10.400864	Ans. $68^\circ 19' 52.7''$
Log. cot. 10.322014	Ans. $25^\circ 28' 25.8''$
Log. cot. 10.076543	Ans. $39^\circ 58' 36.6''$
Log. cos. 9.823456	Ans. $48^\circ 14' 35.1''$

PROBLEM VI. To find the degrees, minutes, and seconds answering to the log. sine or tangent of an arc under above 87° .

1. To find the arc corresponding to a given log. sine.

Add together the given log. sine, the constant number 5.314425, and one-third of the supplement of the corresponding cos., the sum will be the log. of the number of seconds the required arc.

2. To find the arc corresponding to a given log. tangent.

Add together the given log. tan. and the constant number 5.314425, and from the sum take two-thirds of the supplement of the corresponding cos., the remainder is the log. of the required arc in seconds.

NOTE. For the arc answering to the log. cos. and cot. take the complement of the arc answering to the log. sin. and tan.

To find the arc whose log. sine is 8.257551

Constant number, 5.314425

$\frac{1}{3}$ Ar. co. cos. 9.999929 = 0.000024

3732.5" log. = 3.572000

Or $1^{\circ} 2' 12.5''$

To find the arc whose log. tan. is 7.848534

Constant number, 5.314425

3.162959

$\frac{2}{3}$ Ar. co. cos. 9.999989 = 0.000007

1455.3" log. 3.162952

Or $0^{\circ} 24' 15.3''$

TABLE OF NATURAL SINES, TANGENTS, &c. TO EVERY 5 THE QUADRANT.

Page 42 *et seq.*

The method of taking out the numbers in this table easily be understood from the rules given for the log. sine &c. When the sine or tan., &c. is not found exactly in the table, proportional parts must be taken. Thus to find the natural sine of $42^{\circ} 32' 40''$.

Natural sine of $42^{\circ} 30'$ = 675590

Diff. for $5'$, $1072 \times 2\frac{2}{3} \div 5$ = 572

Natural sine of $42^{\circ} 32' 40''$ = 676162

TABLE OF THE AREAS OF CIRCULAR SEGMENTS.

Pages 47 and 48.

This table contains the areas of circular segments whose height, or versine of their half arc, are the numbers immediately on their left; the diameter of the circle being 1, and the whole area $\cdot 785398$. Its use will be best understood from an example: Thus, to find the area of a segment of a circle of which the height is 12, and the diameter of the circle 48,

$12 \div 48 = \cdot 250$ versine of half the arc, then opposite to this number in the table is $\cdot 153546$, and $\cdot 153546 \times 48^2 = 324\cdot 903336$ the area.

When a segment greater than a semicircle is given, subtract the quotient of its versine, divided by its diameter from 1; then subtract the tabular segment which answers to the remainder from $\cdot 785398$, the area of the circle, and the result will be the tabular area corresponding to the segment required.

TABLE OF SQUARES, CUBES, AND ROOTS.

Page 49 *et seq.*

This table will be found very convenient in all cases where the raising of powers or the extraction of roots is required, and so far as it goes needs no explanation; but it is necessary to show, how the powers and roots of numbers not contained in the table may be found by its aid.

PROB. I. To find the square of a number consisting of more than three figures.

Consider the number as composed of the sum of two other numbers, both of which, or their 10th, 100th, &c. parts, are found in the table, then, from the formula $(x + y)^2 = x^2 + 2xy + y^2$ we obtain this

RULE. To the sum of the square of the two parts add twice their product for the square required.

1. To find the square of 2784, we have first,

$$\begin{array}{rcl}
 & 2784 & = 2780 + 4 \\
 \text{Now } & 2780^2 & = 7728400 \\
 \text{Then } & 4^2 & = 16 \\
 \text{And } & 2780 \times 4 \times 2 & = 22240 \\
 \text{Hence } & 2784^2 & = \underline{7750656}
 \end{array}$$

2. To find the square of 58674, we have first,

$$\begin{array}{rcl}
 & 58674 & = 58600 + 74 \\
 \text{Now } 58600^2 & & = 3433960000 \\
 \text{Then } 74^2 & & = 5184 \\
 \text{And } 58600 \times 74 \times 2 & & = 8672800 \\
 \hline
 \text{Hence } 58674^2 & & = 3442637984
 \end{array}$$

When the last digit exceeds 6, or the two last exceed 60, &c. it will be found easier to use the formula $(x - y)^2 = x^2 - 2xy + y^2$; that is, from the sum of the squares of the two parts take twice their product for the square required.

3. To find the square of 78475, we have first,

$$\begin{array}{rcl}
 & 78475 & = 78500 - 25 \\
 \text{Now } 78500^2 & & = 6162250000 \\
 \text{Then } 25^2 & & = 625 \\
 & & \hline
 & & 6162250625 \\
 \text{And } 78500 \times 25 \times 2 & & = 3925900 \\
 \hline
 \text{Hence } 78475^2 & & = 6158325625
 \end{array}$$

PROB. II. To find the cube of a number consisting of more than three places.

Consider the given number as composed of the sum or difference to two other numbers, then apply the formula $(x \pm y)^3 = x^3 \pm 3x^2y + 3xy^2 \pm y^3$.

1. To find the cube of 7864, we have first,

$$\begin{array}{rcl}
 & 7864 & = 7860 + 4 \\
 \text{Now } 7860^3 & & = 485587656000 \\
 \text{Then } 7860^2 \times 3 \times 4 & & = 741355200 \\
 \text{And } 7860 \times 3 \times 4^2 & & = 377280 \\
 \text{Also, } 4^3 & & = 64 \\
 \hline
 \text{Hence } 7864^3 & & = 486329388544
 \end{array}$$

2. To find the cube of 35675, we have first,

$$35675 = 35700 - 25$$

$$\text{Now } 35700^3 = 45499293000000$$

$$\text{And } 35700 \times 3 \times 25^2 = 66937500$$

$$\hline 45499359937500$$

$$\text{Also, } 35700^2 \times 3 \times 25 = 95586750000$$

$$\text{And } 25^3 = 15625$$

$$\hline 95586765625$$

$$\hline \text{Hence } 35675^3 = 45403773171875$$

PROB. III. To find the square root of any number by the table.

Multiply or divide the number by 10, 100, &c. as the case may require; thus since

$$\sqrt{.576} = \frac{1}{100} \sqrt{5760},$$

$$\sqrt{57.6} = \frac{1}{10} \sqrt{5760},$$

$$\sqrt{57.6} = \frac{1}{10} \sqrt{576},$$

$$\sqrt{57648} = 10 \sqrt{576.48},$$

it is manifest, that the extraction of the square root of any number depends upon finding the square root of a number consisting of two or three integral figures, with decimals.

Now let x = any number of which the square root is to be found, and let r = an approximate root, and let c = the difference between \sqrt{x} and r , that is, $\sqrt{x} = r + c$; then

$$x = r^2 + 2rc + c^2, \text{ multiply by } 2r$$

$$2rx = 2r^3 + 4r^2c + 2rc^2$$

Add c^3 to both sides of this equation, and we have

$$2rx + c^3 = 2r^3 + 4r^2c + 2rc^2 + c^3$$

$$\text{Or } 2r(x - r^2) + c = \{3r^2 + (r+c)^2\}c = (3r^2 + x)c$$

$$\text{Whence } c = \frac{2r(x - r^2)}{3r^2 + x} + \frac{c^3}{3r^2 + x}$$

And as the last term is so small as not to affect the sixth place

of decimals, we may reject it, and we will have $c = \frac{2r(x-r^2)}{2r^2+x}$

Or $\sqrt{x} = r + \frac{2r(x-r^2)}{2r^2+x}$ very nearly, that is,

Take the root of the nearest integral number, found in the table, for an approximate root, then divide the product of the difference between the given number and the nearest integer, into double the approximate root, by three times the nearest integral number + the given number, and add the quotient to the approximate root.

1. To find the square root of 347.5, first,

$$\sqrt{347} = 18.627936$$

$$1.0 = 2 \times .5$$

$$3 \times 347 + 347.5 = 1388.5 \quad \begin{array}{r} 18.627936 \\ \hline \end{array}$$

$$\begin{array}{r} .013416 \\ \hline \end{array}$$

$$\sqrt{347.5} = 18.641352$$

2. To find the square root of 4756, first,

$$\sqrt{4756} = 10\sqrt{47.56}, \text{ then}$$

$$\sqrt{47} = 6.855655$$

$$1.12 = 2 \times .56$$

$$3 \times 47 + 47.56 = 188.56 \quad \begin{array}{r} 7.67833360 \\ \hline \end{array}$$

$$\begin{array}{r} .0407208 \\ \hline \end{array}$$

$$\sqrt{47} = 6.855655$$

$$\text{Hence } \sqrt{4756} = 68.963758$$

PROB. IV. To find the cube root of any number by the table.

Multiply or divide the given number by such a cube as will bring the integral part within the limits of the table, then, as in the preceding problem,

$$\text{Let } \sqrt[3]{x} = r + c$$

$$\text{Then } x = r^3 + 3r^2c + 3rc^2 + c^3, \text{ mult. by } 3r$$

$$3rx = 3r^4 + 9r^3c + 9r^2c^2 + 3rc^3$$

$$\text{Or } 3r(x - r^3) = 6r^3c + 3r^3c + 9r^2c^2 + 3rc^3$$

Add $6rc^3 + 3c^4$ to both sides, and we have

$$3r(x - r^3) + 6rc^3 + 3c^4 = \{6r^3 + 3(r+c)^3\}c$$

$$\text{Or } 3r(x - r^3) + 6rc^3 + 3c^4 = (6r^3 + 3x)c$$

$$\text{Hence } c = \frac{3r(x - r^3)}{6r^3 + 3x} + \frac{6rc^3 + 3c^4}{6r^3 + 3x} = \frac{r(x - r^3)}{2r^3 + x} + \frac{2rc^3 + c^4}{2r^3 + x},$$

and rejecting the last term as not affecting the sixth place of decimals, we have

$$\sqrt[3]{x} = r + \frac{r(x - r^3)}{2r^3 + x} \text{ very nearly; that is,}$$

Take the root of the nearest integral number found in the table, as an approximate root, then divide the product of the difference between the given number and the nearest integral number, into the approximate root, by twice the integral number, + the given number, and add the quotient to the approximate root.

1. To find the cube root of 668.75, first,

$$\begin{array}{rcl} \sqrt[3]{668} & = & 8.741625 \\ & & .75 \end{array}$$

$$2 \times 668 + 668.75 = 2004.75 \quad \underline{6.55621875}$$

$$.0032703$$

$$\sqrt[3]{668} = 8.741625$$

$$\text{Hence } \sqrt[3]{668.75} = 8.744895$$

When the integral part consists of three figures, multiply the difference between the root of the integer, and the next higher root by the decimal part, and add the product, the sum will be the root of the whole true to six places.

$$\begin{array}{rcl} \text{Thus, } \sqrt[3]{668} & = & 8.741625 \quad \text{Diff. } .004360 \\ & & .003270 \quad .75 \end{array}$$

$$\sqrt[3]{668.75} = 8.744895 \quad \underline{21800}$$

$$30520$$

$$\underline{.00327000}$$

2. To find the cube root of 74·865, first,

$$\begin{aligned}\sqrt[3]{74\cdot865} &= \frac{1}{2} \sqrt[3]{8 \times 74\cdot865} = \frac{1}{2} \sqrt[3]{598\cdot92} \\ \sqrt[3]{598} &= 8\cdot424945 \\ \sqrt[3]{599} &= 8\cdot429638 \\ &\quad \cdot004693 \text{ diff.} \\ &\quad \quad 92 \\ &\quad \quad \cdot00431756 \text{ correction}\end{aligned}$$

$$\begin{aligned}\sqrt[3]{598} &= 8\cdot424945 \\ &\quad \quad 2)8\cdot429262\end{aligned}$$

$$\sqrt[3]{74\cdot865} = 4\cdot214631$$

$$\text{Or } \sqrt[3]{74} = 4\cdot198336$$

$$\quad \quad \quad \cdot865$$

$$2 \times 74 + 74\cdot865 = 222\cdot865)3\cdot631560640$$

$$\begin{aligned}&\quad \quad \quad \cdot016295 \\ \sqrt[3]{74} &= 4\cdot198336 \\ \sqrt[3]{74\cdot865} &= 4\cdot214631 \text{ as before.}\end{aligned}$$

TABLE OF THE LENGTHS OF CIRCULAR ARCS.

Page 57.

The use of this table is to express an arc of any number of degrees, minutes, &c. in parts of the radius, and conversely, to find the length of an arc of $45^\circ 16' 18''$.

$$\begin{aligned}45^\circ &= \cdot7853982 \\ 16' &= 46542 \\ 18'' &= 873 \\ &\quad \cdot7901397 \text{ the length of the arc.}\end{aligned}$$

To find the number of degrees, minutes, and seconds in an arc whose length is $\cdot9738764$.

Given length,	.	.	·9738764
Next less in table 55°	.	.	·9599311
			<hr/>
			139453
Next less	47'		136717
			<hr/>
			2736
Next less	56''		2715
			<hr/>
	Tab. diff.		48)210(44
			192
			<hr/>
			180

Or 55° 47' 56·44'' nearly.

TABLE OF RECIPROCALS.

Pages 58 and 59.

This table will be found extremely useful on many occasions; it will answer as a table of decimal equivalents, by simply multiplying the reciprocal of the denominator by the numerator of the fraction; thus,

To find the decimal equivalent of $\frac{6}{37}$.

The reciprocal of 37 is	·027027027
	<hr/>
	6

Hence the decimal equivalent of $\frac{6}{37}$ is = ·162162162

It will likewise answer for numbers 10, 100, &c. times greater or less, by simply shifting the decimal point; thus, the reciprocal of 496 is ·002016129 of 4·96 it is ·2016129, and of 49600 it is ·00002016129, and so on.

TABLE OF LOGARITHMS TO 7 PLACES.

Page 59.

This table will be found useful in calculations of interest, &c. at all rates from $\frac{1}{10}$ to 10 per cent.

TABLE OF DIFFERENCE OF LATITUDE AND DEPARTURE.

Pages 60 and 61.

This table gives the sides and angles of right-angled plane triangles, the two legs being represented by the difference of latitude and departure, the hypotenuse by the distance, and the two acute angles by the course, and its complement. Now if any two of these are given except the acute angles, the others may be found by inspection. The course is given in degrees, and in points and quarter-points, in the two columns on the left, and also in the two columns on the right-hand side of the page, the distance is at the top of the page when the course is under 45° , or 4 points, otherwise it is at the bottom, and the difference of latitude and departure is found in columns under or above these words respectively.

If the course contains minutes, and great accuracy be required, proportional parts must be taken; but, in general, when the minutes are under 30' they may be neglected, and when they are above 30' the course may be increased by 1° .

The distances 1, 2, 3, &c. at the top and bottom may be accounted 10, 20, 30, &c. or 100, 200, 300, &c. if the difference of latitude and departure be increased in the same proportion, by removing the decimal point a corresponding number of places to the right. When the distance consists of two, three, &c. significant figures, the difference of latitude and departure must be found for each figure separately, and the results added.

PROBLEM I. To find the difference of latitude and departure, the course and distance being given.

Find the course in the right or left-hand column, and in a line with it under or above the given distance, the difference of latitude and departure will be found; thus,

A ship sails W. N. W. 60 miles, required her difference of latitude and departure?

Course.	Dist.	Diff. of Lat.	Departure.
6 points	60 miles	22.961	55.433

A ship sails 126 miles N. $49^\circ 38'$ W., required her difference of latitude and departure?

Course.	Dist.	Diff. Lat.	Departure.
50°	100	64·279	76·604
	20	12·856	15·321
	6	3·8567	4·5963
	<hr/> 126	<hr/> 80·9917	<hr/> 96·5213

PROBLEM II. To find the course and distance, the difference of latitude and departure being given.

Find in the table, standing together, the difference of latitude and departure which are nearest to those given, and directly opposite in the margin, you will find the course, and at the top or bottom of the column the distance.

NOTE. If the difference of latitude and departure given are not found nearly in the table, take any aliquot parts of them to find the course, and multiply the distance thus found by the divisor used in finding the aliquot parts for the whole distance.

Given the difference of latitude 71·13 N., and the departure 36·32 E., required the course and distance?

Here the diff. of latitude and departure are nearly found in the column marked 8 at the top, and on the margin is 27°, this gives for the distance 80 miles, and the course 27°; between N.N.E. and N.E. by N.

Given the difference of latitude 96·5 miles S., and the departure 57·4 miles W., required the course and distance?

Here the numbers themselves are not to be found, but $\frac{1}{16}$ of them, or 6·03 and 3·53 are nearly found under 7, which multiplied by 16 gives 112 miles, the distance, and in the margin is 30°; between S.W. by S. and S.S.W., the course.

PROBLEM III. To work a traverse.

Find the difference of latitude and departure for each course, and place them in columns marked East or West, and North or South, respectively, then the difference of the sums of the columns marked East and West will give the departure, and the difference of the sums of the columns marked North and South will give the difference of latitude in the whole traverse.

A ship sailed S.W. by W. 58 miles, S.W. 32 miles, N.E. by N. 6 miles, required the difference of latitude and departure, and the course and distance made good?

Courses.	Dist.	N.	S.	E.	W.
S.W. by W.	58		32.2		48.2
S.W. . .	32		22.6		22.6
N.E. by N.	6	5.0		3.3	
		5.0	54.8	3.3	70.8
			5.0		3.3
	Diff. Lat. 49.8			Dep. 67.5	

The difference of latitude and departure not being together in the table, we divide both by $10\frac{1}{2}$, then under and opposite the quotients 4.7429 , and 6.4286 nearly, we find $4\frac{3}{4}$ points or nearly $53\frac{1}{2}^\circ$. Hence the course made good is $53\frac{1}{2}^\circ$ W. and distance $= 8 \times 10\frac{1}{2} = 84$ miles.

TABLE OF ATMOSPHERICAL REFRACTIONS.

Pages 62 and 63.

The rays of light, in passing through the atmosphere, are bent from their rectilineal direction towards the perpendicular, and describe a curve; in consequence of this, a celestial body, except when in the zenith, appears higher than it really is to do: Hence the corrections in this table must always be subtracted from the observed altitude in order to obtain the true altitude.

When the instruments used only take the angles to minutes, it will be sufficient to take the refraction to the nearest minute.

The formula from which the table is calculated is $\cdot 000866 r + (2.47 + .5v^2) \frac{r^2}{s^3} + 3600 v \frac{r^3}{s^3} + 3600(1.235 + .25v^2) \frac{r^4}{s^5}$ where r is the refraction, v the sine of the altitude, and s the cosine.

The apparent altitude, or that obtained from observation, is found in the first column, and in the second the refraction is found when the barometer stands at 30 inches, or its height at the level of the sea when Fahrenheit's thermometer is at 50° . The difference for one minute of altitude is found in the third column; the correction for one inch the barometer exceeds or wants of 30 is given in the four

lumn, and in the last the correction for each degree the thermometer is above or below 50° .

NOTE. The correction for altitude is to be subtracted when the observed altitude is greater than that with which you enter the table, and added when the observed altitude is less. When the barometer is above 30° the correction is to be added, otherwise subtracted. And the correction when the thermometer is above 50° is to be subtracted, and added when the thermometer is below 50° .

1. When the observed altitude is $14^{\circ} 25'$, the barometer at 29.56 inches, and the thermometer at 68° ; what is the true refraction?

	Diff. alt. $\cdot 27''$	Bar. $7.52''$	Ther. $\cdot 458''$
	$5'$	$\cdot 44$	18°
Alt. $14^{\circ} 20'$ refr. $3' 44.4''$	$— 1.35$	$— 3.31$	$— 8.24$
Corrections, — 12.9			3.31
	$3' 31.5''$	true refraction.	1.35
			$— 12.90$

Again,

	Diff. alt. $\cdot 27''$	Bar. $7.52''$	Ther. $\cdot 458''$
	$5'$	$\cdot 44$	18°
Alt. $14^{\circ} 30'$ refr. $3' 41.8''$	$+ 1.35$	$— 3.31$	$— 8.24$
	1.35		3.31
	$3' 43.15$		11.55
	11.55		
	$3' 31.6''$	true refraction.	

2. When the apparent altitude is $10^{\circ} 32' 48.6''$, the barometer at 30.74 inches, and the thermometer at 47° , what is the true altitude?

Alt. $10^{\circ} 30'$ refr. $5' 5''$	Diff. alt. $\cdot 5''$	Bar. $10.2''$	Ther. $\cdot 64''$
1.4	$2' 48.6'' = 2.8$	$\cdot 74$	3°
$5' 3.6$	$— 1.4$	$+ 7.55$	$+ 1.92$
7.55			
1.92			
Refraction, $5' 13.07''$		App. altitude, $10^{\circ} 32' 48.6''$	
		Refraction, $5' 13.07''$	
		True altitude, $10^{\circ} 27' 35.53''$	

TABLE FOR REDUCING LONGITUDE INTO TIME, AND THE
CONTRARY.

Page 64.

The use of this table is obvious; thus,

To convert 15 hours 43 minutes 27 seconds into degrees minutes, &c.

15 hours	=	225°
43 min.	=	10° 45'
27 sec.	=	6' 45"
<hr/>		
15 hours 43 min. 27 sec.	=	235° 51' 45"

To convert 187° 51' 36" to hours, minutes, &c.

180°	=	12 hours
7°	=	28 min.
51'	=	3 24 sec.
36"	=	2 24 th.
<hr/>		
187° 51' 36"	=	12 hours 31 min. 26 sec. 24 th.

TABLE OF MERIDIONAL PARTS TO EVERY DEGREE OF THE
QUADRANT.

Page 64.

This table is used in Mercator's sailing for obtaining the enlarged difference of latitude when the true is given, or the true difference when the enlarged is given. The degrees are found under D., and the meridional parts under M.P.; when the latitude is given to minutes and seconds, proportional parts of the difference for one degree must be taken.

PROBLEM I. To find the enlarged difference of latitude when both latitudes are given.

When the latitudes are of the same name, take the differ-

ence of the meridional parts, otherwise take the sum for the enlarged difference of latitude; thus,

Let the latitudes be $46^{\circ} 30' \text{ N.}$ and $25^{\circ} 20' \text{ N.}$

46° M. P.	3115.6	
$\cdot \text{ P. P. of } 87.1, \text{ to } 30' =$	43.5	
$\text{M. P. for } 46^{\circ} 30'$		3159.1
25° M. P.	1550.0	
$\text{P. P. of } 66.5, \text{ to } 20' =$	22.2	
$\text{M. P. for } 25^{\circ} 20'$		1572.2
Enlarged diff. of latitude,		1586.9

Again, let the latitudes be $46^{\circ} 30' \text{ N.}$ and $25^{\circ} 20' \text{ S.}$

Then, as before, $\text{M. P. for } 46^{\circ} 30'$	3159.1
$\text{M. P. for } 25.20'$	1572.2
Enlarged diff. of latitude,	4731.3

PROBLEM II. Given one latitude, and the enlarged difference of latitude to find the other latitude.

I. When the ship sails away from the equator, add the M. P. corresponding to the given latitude to the given enlarged difference, find the sum nearest to it in the table, and in the column on the left of it are the degrees, and for the minutes multiply the difference by 60, and divide the product by the difference of the M. P. of the degree found and the next higher one; thus,

A ship in latitude $15^{\circ} 30' \text{ N.}$ sails northerly, and the enlarged difference of latitude is 2781, required the latitude at which she has arrived?

$15^{\circ} \text{ Meridional Parts,}$	910.5	
$\text{P. P. of diff. } 62.2, \text{ for } 30'$	31.1	
Enlarged diff. of latitude,	2781	
		3722.6
52° M. P.		3665.2
Diff. of M. P. for 52° and $53^{\circ} =$	98.6	57.4
		60
		98.6)3444.0(
Latitude sought $52^{\circ} 34.8' \text{ N.}$		34.8'

II. When the ship sails towards the equator, take the difference between the given difference of latitude and the M. P. corresponding to the given latitude, and the number of degrees and minutes answering to the remainder is the latitude arrived at.

NOTE. When the enlarged difference of latitude is greater than the meridional parts, it shows that the ship has crossed the equator, and the latitude will then be of a different name from that given.

A ship in latitude $30^{\circ} 15' N.$ sails southerly till the enlarged difference of latitude is found to be 1570.3, in what latitude has she arrived?

30° M. P.	. . .	1888.4	
P. P. of diff. 69.6, for 15'		17.4	
		<hr/>	
			1905.8
Enlarged diff. of latitude,	. . .		1570.3
			<hr/>
			335.5
M. P. for 5°	. . . . .		300.4
			<hr/>
Diff. of M. P. for 5° and 6° = 60.3			35.1
			60
			<hr/>
			60.3)2106.0
			<hr/>
Latitude sought $5^{\circ} 34.9' N.$			34.9'

A ship in $6^{\circ} 36' N.$ sails southerly until the enlarged difference of latitude is found to be 7748, in what latitude has the ship arrived?

Enlarged difference of latitude,	. . .	7748	
M. P. for 6°	. . .	360.7	
P. P. of diff. 60.4, for 36'		36.2	
		<hr/>	
			396.9
			<hr/>
			7352.9
M. P. for 76°	. . . . .		7210.1
			<hr/>
Diff. between M. P. for 76° and 77° = 257.1			142.8
			60
			<hr/>
			257.1)8568.0
			<hr/>
Hence the lat. arrived at is $76^{\circ} 33.3' S.$			33.3'

TABLE FOR REDUCING MEAN SOLAR TO SIDEREAL TIME.

Page 65.

This table is useful when double altitudes of a star are taken to determine the latitude, the elapsed time measured by a chronometer or a watch must be reduced to sidereal time.

Required the sidereal time corresponding to 6 hours 47 minutes 50 seconds of mean solar time?

For 6 h. mean solar time add 0 h. 0 m. 59.14 sec.

47 m. do. do. 7.72

50 sec. do. do. 0.14

Given mean solar time, 6 47 50

Required sidereal time, 6 h. 48 m. 57 sec.

TABLE FOR REDUCING SIDEREAL TO MEAN SOLAR TIME.

Page 65.

This table is used when the time of a celestial object's passage over the meridian is noted by a sidereal clock, and it is required to find the corresponding solar time.

Required the mean solar time corresponding to 7 hours 45 minutes 27 seconds of sidereal time?

Given sidereal time, . . . 7 h. 45 m. 27 sec.

For 7 h. sidereal time subtract 1 8.81

45 m. do. do. 7.37

27 sec. do. do. 0.07

Acceleration of sid. on mean solar time, 1 16.25

Required mean solar time, . 7 h. 44 m. 10.75 sec

TABLE FOR FINDING THE EQUATION OF TIME FOR ANY GIVEN TIME UNDER ANY MERIDIAN; FOR FINDING THE TIME OF THE MOON'S PASSAGE OVER ANY GIVEN MERIDIAN ON ANY GIVEN DAY; AND ALSO FOR FINDING THE MOON'S HORIZONTAL SEMIDIAMETER, OR PARALLAX FOR ANY GIVEN TIME UNDER ANY GIVEN MERIDIAN.

Page 66.

The following examples will show the manner of using the table:—

1. Required the equation of time, October 14, 1841, hours 14 minutes in longitude $64^{\circ} 30' W.$?

Equation of time for noon at Greenwich, 13 m. 56

Variation for next 24 hours + 13.2 sec.

Given time, 10 h. 14 m.

Long. in time, 4 16

Greenw. time, 14 30, opposite this and

under 10 sec. is 6

Proportional parts for 3.2 sec. 1

Equation of time required, 14 m. 4

2. Required the time of the moon's passage over the meridian, May 25, 1841, in longitude $75^{\circ} E.$?

Time of moon's passage over the meridian of Greenwich

May 25, 1841, 4 h. 3

Variation in next 24 hours + 52.7 m.

Long. in time 5 h., opposite this and under

50 m. is 10.4 } 0 1

Proportional parts for 2.7 0.6

Time of passage required 4 h. 2

3. Required the moon's horizontal semidiameter, May 1841, at 10 hours 30 minutes in longitude $75^{\circ} E.$?

Horizontal semidiam. for noon at Greenwich, 16 h. 1

Variation for next 12 h. — 4.1 sec.

Given time, 10 h. 30 m.

Long. in time, 5 0

Greenwich time, 5 h. 30 m., opposite this, and

under 4 sec. is

Horizontal semidiameter required, 16 h. 1

4. Required the moon's horizontal parallax, May 25 at 10 hours 30 minutes at Greenwich?

Hor. par. for noon on 25th May 1841, 59 h. 4

Variation for next 12 hours — 15 sec.

Time before noon, 1 h. 30 m., opposite this

and under 10 sec. is 0.6 } 0.3

Proportional parts for 5 sec.

Horizontal parallax required 59 h. 4

TABLE OF THE DEPRESSION OR DIP OF THE HORIZON.

Page 67.

This table contains the angle which a line drawn from the eye of the observer to the visible horizon or edge of the water, makes with a true horizontal line passing through his eye. The numbers corresponding to the height of the eye are to be subtracted from the observed altitude when taken by the fore observation, but added to it when taken by the back observation.

TABLE OF THE DIP AT VARIOUS DISTANCES FROM THE
OBSERVER.

Page 67.

The former table contains the dip answering to an entirely unobstructed horizon; but as observations may be sometimes taken to obtain an altitude referred to the surface of the sea at some known or estimated distance, this table, in which the distance of the ship from the shore is placed in the margin, and the height of the eye at the top, must be used.

On the 30th May 1840, under the longitude of Greenwich, the altitude of the sun's lower limb was observed at $49^{\circ} 54' 12''$ S., the observer's height was 18 feet above the level of the sea, the barometer was at 29.8 inches, and Fahrenheit's thermometer was at 58° . Required the latitude?

Observed altitude of lower limb,	49° 54' 12" S.
Refraction,	— 47.7
Dip,	— 4 11
Sun's semidiameter,	+ 15 47.3
Sun's parallax,	+ 8.46
Corrected Altitude,	50 5 9 S.
Zenith Distance,	39 54 51 N.
Declination,	21 49 51.7 N.
Latitude of the place,	61 44 42.7 N.

TABLE FOR FINDING THE DISTANCE OF OBJECTS AT SEA IN
STATUTE MILES OF ABOUT $69\frac{1}{2}$ TO A DEGREE.

Page 67.

The use of this table is best shown by an example : thus,

On board a ship, my eye being 40 feet above the sea, I discover a lighthouse 180 feet high, just appearing in the horizon; required my distance from the lighthouse ?

Opposite 40 feet in the table is 8.37 miles.

180 . . . 17.75

The distance is 26.12 miles.

A man in the main-top-gallant-mast of a man of war, 220 feet above the water, sees a 100-gun ship, she had engaged the preceding day, hull to; how far are those ships distant from each other ?

A ship of 100 guns is nearly 60 feet from the keel to the rails, from which deduct 25, her draft of water, leaves 35 feet for the height of her quarter-deck above water; and a ship is seen hull to when her upperworks just appear.

Opposite 220 feet in the table is 19.62 miles.

35 . . . 7.83

The distance between them, 27.45 miles.

When an object, of which the height above the horizon is to be determined, is at a very great distance, it is necessary to take into account the correction arising from the curvature of the earth and from refraction. Thus, if the angle of elevation of a mountain, whose base is more distant than the limit of the visible horizon, was observed, by an instrument of reflection, its approximate height must first be calculated, and then the correction of that approximate height for the curvature of the earth, refraction, and dip, calculated, and applied to that height, for the true height above the sea. This is very easily performed by the aid of the table; thus, Find the number of miles answering to the height of the observer's eye above the sea, and take the difference between it, and the distance of the mountain from the observer, in statute miles; find this number in the table, under the title Distance, and

immediately opposite, will be found the number of feet to be added to the approximate height of the mountain, to find its true height above the level of the sea.

Suppose the distance of the mountain 40 miles (or 211,200 feet), and the observed altitude $1^{\circ} 3' 30''$, the observer being 20 feet above the level of the sea; required the height of the mountain?

As rad.	.	10.000000	Dist. of mount. 40 miles.
Is to 211200		log. 5.324694	20 feet table, 5.92
So is $1^{\circ} 3' 30''$		tan. 8.266549	$663.5 = 34.08$
Approx. height, $3901.6 = 3.591243$			
Correction, 663.5			

Sum, 4565.1 feet is the true height, nearly, above the level of the sea.

TABLES FOR CALCULATING THE HEIGHT OF MOUNTAINS.

Page 68 *et seq.*

These tables were calculated by M. Oltmanns, and published in the *Annuaire*, by the French Board of Longitude, who characterized them as "the most convenient of any previously published for facilitating the calculation of heights." They are here given in English feet and inches, and adapted to Fahrenheit's scale.

Let h be the height of the barometer in inches at the lower station; h' that at the higher; T and T' the temperature of the barometer, as shown by an attached Fahrenheit's thermometer, at the lower and higher station; and t and t' that shown by detached thermometers, or the temperature of the air.

From Table I. take out the number which corresponds to h , or the next less than h which is found in the table. Enter Table II. with the difference found in Table I. on the left-hand column, and the difference between h and the number used in Table I. at the top, and take out the corresponding number; add these together and call their sum a . In the same manner, take out the number answering to h' and call it b . From Table III. take out the number answering to $T - T'$ and call it c , then the approximate height of the upper station is $a - b - c$; but if $T - T'$ is negative, the approximate height is $a - b + c$.

To this approximate height we must apply a correction the difference of temperature between the lower and higher stations, as indicated by the detached thermometers; which is found thus: Take 32° from each, and to the sum of remainders add one-ninth of itself, then multiply it by a thousandth part of the approximate height. The correction will be positive or negative according as the sum of $t + t' - 64$ is greater or less than 32° . If t and t' are less than 32° , the number of degrees they are below it must be used in the same manner to obtain the correction which will then be negative.

The next correction, which is always additive, arises from the latitude, or the diminution of gravity, and is found by entering Table IV. with the last approximate height, in the left-hand column, and the degrees of latitude at the top of the page.

1. Find the height of Guanaxuato in Mexico, latitude 21° from the following observations of M. de Humboldt.

At the lower station or level of the sea the barometer was 30.045 inches, $= h$, the attached thermometer, $77.5^\circ = t$ and the detached thermometer $77.5^\circ = t$. At the upper station the barometer was 23.659 in. $= h'$, the attached thermometer $70.5^\circ = T'$ and the detached thermometer $70.5^\circ = t'$.

Table I. Opposite	30000	is	202
II. { Opp. 43 and under	40	is	
{ Opp. 43 and under	5	is	
			<hr/>
			$a = 202$

Table I. Opposite	23650	is	14034
II. Opp. 55 and under	9	is	9.9
III. $T - T' = 7$ opposite which is			18.8
			<hr/>
			$b + c = 140$

Approximate height $= a - b - c$	$= 62$
$t - 32^\circ = 77.5^\circ - 32^\circ = 45.5^\circ$	
$t' - 32^\circ = 70.5^\circ - 32^\circ = 38.5^\circ$	
$\frac{84.0^\circ}{84.0^\circ}$	

And $84 + \frac{84}{9} = 93.3$ and 93.3×6.224	$= 588$
<hr/>	
	68

Table IV. Opposite 6805 and under 21° is, say,	
Height in English feet,	68

2. Required the height of the Peak of Snowdon, lat. $53\frac{1}{4}^{\circ}$, above Caernarvon quay, from the following observations?

At lower station, barometer 29.984 inches; attached thermometer 56.5° ; detached thermometer 55.25° . At higher station, barometer 26.271 inches; attached thermometer 42.75° ; detached thermometer 43° .

Table I. Opposite	29.950	is	20204
II. { Opp. 43 and under	30	is	25.8
{ Opp. 43 and under	4	is	3.4
<hr/>			
$a = 20233.2$			

Table I. Opposite	26.250	is	16760
II. { Opp. 50 and under	20	is	20
{ Opp. 50 and under	1	is	1
T — T' = 13.75° opp. to which is	36.5		
<hr/>			
$b + c = 16817.5$			

$$\text{Approximate height} = a - b - c = 3415.7$$

$$t - 32^{\circ} = 55.25^{\circ} - 32^{\circ} = 23.25^{\circ}$$

$$t' - 32 = 43^{\circ} - 32 = 11^{\circ}$$

$$9)34.25^{\circ}$$

$$3.8$$

$$38 \times 3.4157 = 129.8$$

$$3545.5$$

Table IV. Opposite 3545 and under $53\frac{1}{4}^{\circ}$ is, say, 8.5

Height in English feet, 3554.0

When the lower station is considerably elevated above the level of the sea, the following table will give a small correction which is always additive.

CORRECTION FOR 1000 FEET OF HEIGHT.

Barom. inches.	Correc. feet.	Barom. inches.	Correc. feet.
16	1.62	24	0.55
18	1.31	26	0.34
20	1.03	28	0.15
22	0.78	29.52	0.03

Let, for example, the height of the lower barometer be 20 inches, and the difference of level 3000 feet; then for the correction we say $1000 : 1.03 :: 3000 : 3.09$ feet; the difference of the level corrected would therefore be 3003.09 feet.

THERMOMETRICAL SCALES.

Page 72.

This table contains the corresponding degrees of Reaumur's and the Centigrade thermometer to each degree of Fahrenheit's scale. Its use is obvious.

TABLE OF THE HEIGHT OF THE APPARENT ABOVE THE TRUE LEVEL.

Page 73.

This table contains the quantities to be subtracted from the height of the mark to which a levelling instrument is directed, in order to obtain the point that is really on a level with the instrument. The curvature of the earth's surface is the cause of the difference.

TABLE OF THE LINKS TO BE SUBTRACTED FROM EACH CHAIN IN AN ASCENDING OR DESCENDING LINE IN ORDER TO REDUCE IT TO THE HORIZONTAL MEASURE.

Page 73.

The first part contains the quantity to be subtracted for each degree of elevation as far as 20° , which is as great an angle as usually occurs in practice; and the second part contains those elevations which require an equal number of links and quarters of a link to be subtracted. This will be more ready in practice, and in using it if we take that elevation which is nearest to the true one we will obtain a sufficiently accurate result.

The next table in the same page contains the angles answering to the subtenses in links measured at the distance of *half a chain* from the angular point.

TABLE OF THE SIDES OF INSCRIBED AND CIRCUMSCRIBED
POLYGONS.

Page 74.

This table is intended to assist practical men in laying off regular polygons, and in finding their contents; thus,

A polygon of 12 sides is to be inscribed in a circle of 60 feet diameter, required the length of the side of the polygon?

$$\begin{array}{r} \text{Tabular number,} \quad .2588190 \\ \quad \quad \quad \quad \quad \quad 60 \\ \hline = 15.5291400 \end{array}$$

15 feet $6\frac{7}{8}$ inches very nearly.

What is the area of a polygon of 8 sides circumscribed about a circle 80 feet in diameter?

Tabular number $.4142136 \times 80 = 33.137088$ feet length of one side, and 33.137088×20 (half the radius) $\times 8$ (the number of sides) $= 662.6176 \times 8 = 5300.9408$ feet $= 588$ yds. 6.94 feet the area required.

TABLES FOR FINDING THE AREAS OF OBLONG AND OBLATE
SPHEROIDS.

Page 75.

These tables are intended to obviate the difficulty of finding the areas of spheroids and elliptical domes.

Divide the difference of the diameters of the spheroid by the less diameter, and the first five figures is the index, opposite to which in the table is the number to be taken out and multiplied by both diameters for the area required; thus,

To find the area of an oblong spheroid whose diameters are 50 and 40. Here $\frac{50 - 40}{40} = \frac{10}{40} = .25000$, the index opposite to which in the table is 2.9413189 and $2.9413189 \times 50 \times 40 = 5882.6378$, the area. The area of this spheroid by Dr Hutton's Rule is 5882.6385.

If the index is not found in the table; take the number opposite the first two figures of the index, and also that immediately under it; multiply the difference between these numbers by the three right-hand figures of the index, and cut off three figures to the right, the remaining figures deducted from the number first taken out will leave the number answering to the spheroid whose area is sought.

NOTE. If the spheroid is oblate, instead of deducting, add, and the sum will be the number sought.

To find the area of an elliptical dome whose diameters at the base are 50 and 30, and its height 15, being half of an oblong spheroid.

Here $\frac{50 - 30}{30} = \frac{20}{30} = .66667$; then

Opposite to .66 in the table is	2.7652036
---------------------------------	-----------

Opposite to .67 in the table is	2.7622314
---------------------------------	-----------

Difference,	29723
-------------	-------

The three right-hand figures of index,	667
--	-----

Product,	19824.574
----------	-----------

Then $2.7652036 - 19824 = 2.7632212$, and $2.7632212 \times 50 \times 15$, the height, = 2072.4159, the area, which by Dr Hutton's Rule is 2072.41315.

Required the area of an oblate spheroid whose diameters are 57 and 33?

$57 - 33 = 24$ and $\frac{24}{33} = .72727$; then

Opposite to 72 in the table is	3.9787360
--------------------------------	-----------

Opposite to 73 in the table is	3.9912539
--------------------------------	-----------

Difference,	125229
-------------	--------

The three right-hand figures of index,	727
--	-----

Product,	91041.483
----------	-----------

Then $3.9787310 + 91041 = 3.9878351$, and $3.9878351 \times 57 \times 33 = 7501.1178$, the area.

How many square yards of cloth are in a balloon in the form of an oblong spheroid whose diameters are 46 feet 6 inches and 36 feet; how many cubic feet of gas will it contain, and what will the gas cost at 9s. per 1000 cubic feet?

$$46.5 - 36 = 10.5, \text{ and } \frac{10.5}{36} = .29166; \text{ then}$$

Opposite 29 in the table is	2.9178936
-----------------------------	-----------

Opposite 30 	2.9123145
-------------------------------------	-----------

Difference,	55791
-------------	-------

The three right-hand figures of index,	166
--	-----

Product,	9261.306
----------	----------

Then $2.9178936 - 9261 = 2.9169675$, and $2.9169675 \times 46.5 \times 36 = 4883.003595$ square feet = 542.555955 square yards of cloth.

Also $36 \times 36 \times 46.5 \times .5236 = 31554.2304$ cubic feet of gas, which at 9s. per 1000 cubic feet = £14, 4s.

TABLE OF JOISTING.

Pages 76 and 77.

In using this table to find the cubic content of the joisting, we have only to multiply the number in the table answering to the size of the joist and the distance between centres, by the number of square yards in the floor (allowing for the holds in the wall), to obtain the cubic content: Thus, the floor of a room, including the holds of the joists in the wall, measures 40 square yards; the joists are 10 inches by 3, and the distance between their centres is 15 inches. Required the solid content of the joisting? The number in the table answering 10 inches by 3, and 15 inches between centres is 1 foot 7 inches 3 parts, and this multiplied by 40 gives 64 feet 2 inches for the solid content.

This table may likewise be used in finding the value of the timber; for the feet in the table are shillings, the inches, pence, and the parts, 12th parts of a penny, &c. when the timber is at 1s. per cubic foot: Thus, when the price of timber is 2s. 9d. per cubic foot, what is the value of a square yard of joisting, 8 inches by 3 inches, and 16 inches between centres?

The number in the table answering to 8 inches by 3 inches, and 16 inches between centres, is 1 foot 2 inches 6 parts. Hence the value of a square yard at 1s. per cubic foot is 1s. 2½d. ; then

$$6d. = \frac{1}{2}s. \quad 1s. \ 2\frac{1}{2}d.$$

2

2 5

$$3d. = \frac{1}{2}$$

7½

3½½

3s. 3¾½ value at 2s. 9d. per cubic yard.

The Miscellaneous Tables, from page 78 to the end, will be readily understood by those for whose use they are intended.

AN EPITOME OF COMPOUND INTEREST AND ANNUITIES CERTAIN.

I. COMPOUND INTEREST.

Let p denote the principal, r the simple interest of £1 for a year, R the amount of £1 at the end of one year $= 1 + r$, n the number of years, and a the amount at the end of n years; then

1. $a = pR^n.$
2. $p = a \times \frac{1}{R^n}.$
3. $r = \sqrt[n]{a \div p} - 1.$
4. $n = (\log. a - \log. p) \div \log. R.$

When the interest is payable m times in a year at m equal intervals; then each payment is the m th part of r , and their number is nm in n years; hence

$$5. a = p \left(1 + \frac{r}{m}\right)^{mn}.$$

When the interest is payable half yearly we have

$$6. a = p \left(1 + \frac{r}{2}\right)^{2n}.$$

And when it is payable quarterly we have

$$7. a = p \left(1 + \frac{r}{4}\right)^{4n}.$$

II. ANNUITIES AT COMPOUND INTEREST.

Let a = the amount of the annuity or periodic payment p , n the number of payments, r the simple interest of £1 for a year, and R the amount of £1 at the end of the first year $= 1 + r$; then

1. $a = \frac{p}{r} \times (R^n - 1).$
2. $p = ar \div (R^n - 1).$
3. $n = \log. (1 + ar \div p) \div \log. R.$
4. $r = \frac{\{12 + (n+1)d\}d}{12 + 2(n+1)d},$ where $d = \left(\frac{a}{p^n}\right)^{\frac{2}{n-1}} - 1.$

60 AN EPITOME OF COMPOUND INTEREST AND ANNUITIES.

When the annuity is payable m times in a year for n years, each payment being the m th part of the annuity, and q the number of payments of interest, each being the q th part of r ; then

$$5. a = \frac{p}{m} \left\{ \left(1 + \frac{r}{q}\right)^{qm} - 1 \right\} \div \left\{ \left(1 + \frac{r}{q}\right)^{\frac{q}{m}} - 1 \right\}.$$

III. PRESENT VALUE OF ANNUITIES AT COMPOUND INTEREST.

Let p denote the present value of an annuity a , for n years, r the simple interest of £1 for a year, and R the amount of £1 at the end of the first year; then

$$1. p = \frac{a}{r} \left(1 - \frac{1}{R^n}\right). \quad 2. a = pr \left(\frac{R^n}{R^n - 1}\right).$$

$$3. n = \{\log. a - \log. (a - rp)\} \div \log. R.$$

If the annuity is to continue for ever, it is then called a *Perpetuity*, and the quantity $R^n - 1$ becomes the same as R^n , in which case we have

$$4. p = \frac{a}{r}; \quad 5. a = pr; \quad \text{and} \quad 6. r = \frac{a}{p}.$$

When the annuity is payable m times in a year for n years, each payment being the m th part of the annuity, and q is the number of payments of interest, each being the q th part of r , then the formula becomes

$$7. p = \frac{a}{m} \left(1 - \frac{1}{\left(1 + \frac{r}{q}\right)^{qm}}\right) \div \left\{ \left(1 + \frac{r}{q}\right)^{\frac{q}{m}} - 1 \right\},$$

and when it is a perpetuity it becomes

$$8. p = \frac{a}{m} \times \frac{1}{\left(1 + \frac{r}{q}\right)^{\frac{q}{m}} - 1}.$$

IV. REVERSIONARY OR DEFERRED ANNUITIES AT COMPOUND INTEREST.

Let p = the present value, a the annuity or periodic payment, n the number of years it is to continue after d years have elapsed, r the simple interest of £1 for a year, and R the amount of £1 at the end of the first year = $1 + r$; then

$$1. p = a \times \left(\frac{1}{R^d} - \frac{1}{R^{n+d}} \right) \div r.$$

$$2. a = pr \div \left(\frac{1}{R^d} - \frac{1}{R^{n+d}} \right).$$

$$3. n = \log. (1 - prR^d \div a) \div \log. R.$$

$$4. d = \{ \log. (1 - \frac{1}{R^n}) - \log. (pr \div a) \} \div \log. R.$$

When the reversion is a perpetuity, $R^n - 1$ becomes the same as R^n ; whence

$$5. p = \frac{a}{r} \times \frac{1}{R^d}.$$

$$6. a = prR^d.$$

$$7. d = (\log. a - \log. pr) \div \log. R.$$

When the annuity is payable m times in a year, each payment being the m th part of the annuity, and q the number of payments of interest in a year, each being the q th part of r ; then

$$8. p = \frac{a}{m} \left(\frac{1}{(1 + \frac{r}{q})^{qd}} - \frac{1}{(1 + \frac{r}{q})^{q(n+d)}} \right) \div \left\{ \left(1 + \frac{r}{q} \right)^{\frac{q}{m}} - 1 \right\}.$$

And for the reversionary perpetuity we have

$$9. p = \frac{a}{m} \left(\frac{1}{(1 + \frac{r}{q})^{qd}} \right) \div \left\{ \left(1 + \frac{r}{q} \right)^{\frac{q}{m}} - 1 \right\}.$$

AN EPITOME OF MENSURATION.

I. PARALLELOGRAMS.

1. In a square whose side is a , the area $= a \times a$, or a^2 .

2. In a right-angled parallelogram of which one side is a , and the other b , the area is $= a \times b$.

3. In any parallelogram of which one side is a , and the perpendicular let fall upon it from the opposite side is p , the area is $= a \times p$.

4. When the two diagonals, d and d' are given ; the area is $= \frac{1}{2}d \times d'$.

5. When two sides a and b and the contained angle c are given, the area is $= a \times b \times \text{nat. sin. } c$.

II. TRIANGLES.

If A, B, C , represent the three sides a, b, c , the angles respectively opposite to these sides, and p the perpendicular falling upon the base B , then

$$1. \text{ Area} = \frac{1}{2}B \times p.$$

$$2. \text{ Area} = \frac{1}{2}A \times B \times \text{nat. sin. } c = \frac{1}{2}A \times C \times \text{nat. sin. } b = \frac{1}{2}B \times C \times \text{nat. sin. } a.$$

$$3. \text{ Area} = \sqrt{\{s \times (s - A) \times (s - B) \times (s - C)\}}, \text{ where } s \text{ is equal to } \frac{A + B + C}{2}.$$

$$4. \text{ Area} = \frac{1}{4}A^2 \sqrt{3}, \text{ when the triangle is equilateral, and } A = \text{the side.}$$

III. TRAPEZIUMS.

Let a and c be two sides opposite each other, b and d the other two opposite sides, e and e' the two diagonals, r the angle formed by their intersection, and p and p' the perpendiculars falling from opposite angles upon the diagonal e ; then

$$1. \text{ Area} = \frac{1}{2}e(p + p').$$

$$2. \text{ Area} = \frac{1}{2}e \times e' \times \text{nat. sin. } r.$$

$$3. \text{ Area} = \frac{1}{4}\{(a^2 + c^2) \oslash (b^2 - d^2)\} \times \text{nat. tang. } r.*$$

4. When the trapezium can be inscribed in a circle, or when the opposite angles are together $= 180^\circ$.

$$\text{Area} = \sqrt{\{(s - a) \times (s - b) \times (s - c) \times (s - d)\}} \text{ where } s \text{ is equal to half the sum of the four sides.}$$

* This formula fails when the diagonals intersect each other at right angles; for then the tangent is infinite, and the difference of the aggregates of the squares is nothing.

5. $\text{Area} = \frac{1}{2}(ab + cd) \times \text{nat. sin. } x$, where x is the angle contained by a and b , or by c and d .

6. If a and c , or b and d be parallel, and p their perpendicular distance, then

$$\text{Area} = \frac{1}{2}p(a + c), \text{ or } = \frac{1}{2}p(b + d).$$

IV. REGULAR POLYGONS.

If s represent one of the sides, n the number of sides, and p the perpendicular from the centre upon s , then

$$1. \text{Area} = \frac{1}{2}p \times s \times n.$$

$$2. \text{Area} = n \times p^2 \times \text{nat. tang. } \frac{360^\circ}{2n}.$$

$$3. \text{Area} = \frac{1}{4}n \times s^2 \times \text{nat. cot. } \frac{360^\circ}{2n}, \text{ or } = \frac{1}{4}n \times s^2 \times \text{nat. tan. } \left(90^\circ - \frac{360^\circ}{2n}\right).$$

4. $\text{Area} = s^2$ multiplied by the multiplier answering the number of sides taken from table, page 81.

V. CIRCLE.

If r represent the radius, d the diameter, and c the circumference, then

$$1. \text{Area} = \frac{1}{4}c \times d.$$

$$2. \text{Area} = .78539 \&c. \times d^2.$$

$$3. \text{Area} = .079577 \&c. \times c^2.$$

$$4. \text{Circumf.} = 3.14159 \times d.$$

$$5. \text{Diameter} = \frac{c}{3.14159 \&c.}, \text{ or } = c \times .31839 \&c.$$

VI. CIRCULAR ARCS.

Let r = the rad. d = diam. of any circle, and s , c , v , t , \sec , the sine, cosine, versine, tangent, and secant of the arc whose length is required, and let the number of degrees and minutes, &c. which it contains, = n ; then

$$1. \text{Arc} = r \times n \times .01745329 \&c.$$

$$2. \text{ Arc} = t - \frac{t^3}{3} + \frac{t^5}{5} - \frac{t^7}{7} + \frac{t^9}{9} - \&c. \times r.$$

$$3. \text{ Arc} = s + \frac{s^3}{2.3} + \frac{3s^5}{2.4.5} + \frac{3.5s^7}{2.4.6.7} + \&c. \times r.$$

$$4. \text{ Arc} = \frac{sec}{c} - \frac{sec^3}{3c^3} + \frac{sec^5}{5c^5} - \frac{sec^7}{7c^7} + \&c. \times r.$$

$$5. \text{ Arc} = 2\sqrt{2v}\{1 + \frac{v}{2^2.3} + \frac{3v^2}{2^3.4.5} + \frac{3.5v^3}{2^4.4.6.7} + \&c.\} \times r.$$

If c = the chord of the whole arc, c' = the chord of h the arc, and h = the height of the segment, or versine of h the arc, then

$$6. \text{ Arc nearly} = 2d\sqrt{\frac{3h}{3d - h}}.$$

$$7. \text{ Arc nearly} = \frac{2}{9}\{5d\sqrt{\frac{5h}{5d - 3h}} + 4\sqrt{dh}\}.$$

$$8. \text{ Arc nearly} = \frac{8c' - c}{3}.$$

VII. CIRCULAR SECTORS.

Let l represent the length of the arc, r the rad. and n number of degrees it contains; then

$$1. \text{ Area} = \frac{1}{2}r \times l.$$

$$2. \text{ Area} = .78539 \&c. \times \frac{4r^2n}{360}.$$

VIII. CIRCULAR SEGMENTS.

Let a represent the area of the circular sector, c chord of the arc, v the versine of half the arc, d the diameter, and r the radius; then

$$1. \text{ Area of segment} = a \pm \frac{1}{2}c(r - v).$$

$$2. \text{ Area} = 2v\sqrt{dv} \times \left\{ \frac{2}{3} - \frac{v}{5d} - \frac{v^2}{28d^2} - \frac{v^3}{72d^3} - \&c. \right\};$$

$$= 2\sqrt{dv} \times \left\{ \frac{2}{3} - \frac{3v}{5.2d} A - \frac{5v}{7.4d} B - \frac{7.3v}{9.6d} C - \frac{9.5v}{11.8d} D - \&c. \right\}$$

where A, B, C, &c. are the preceding terms.

$$3. \text{ Area} = \frac{4}{3} v\sqrt{vz} + \frac{v}{5z} A - \frac{v}{7z} B + \frac{3v}{9z} C - \frac{5v}{11z} D + \&c.,$$

where $z = (d - v)$, and A, B, C, &c. denote the preceding terms.

$$4. \text{ Area} = 2rc' - \frac{1}{2.3} q^2 A - \frac{1.3}{4.5} q^2 B - \frac{3.5}{6.7} q^2 C, \&c.$$

where c' is the cosine of half the arc, and $q = \frac{c'}{r}$; A, B, C, &c. being the preceding terms.

$$5. \text{ Area nearly} = \frac{4}{5} v \left\{ \sqrt{(dv - v^2)} + \frac{2}{3} \sqrt{dv} \right\}.$$

$$6. \text{ Area nearly} = \frac{4}{3} v (dv - \frac{3}{5} v^2).$$

If x = the chord of half the arc; then

$$7. \text{ Area nearly} = \frac{4}{10} v (c + \frac{4}{3} x).$$

$$8. \text{ Area nearly} = \frac{4}{3} v \sqrt{(\frac{1}{4} c^2 + \frac{2}{5} v^2)}.$$

9. Area nearly = $d^2 \times$ tabular number answering to $\frac{v}{d}$ in the table of circular segments, page 47.

NOTE. The area of a circular zone is found by taking the difference of the areas of the two segments; and the area of a circular ring, by taking the difference of the areas of the two circles; or if d' and d be the two diameters, then the area of the ring = $(d' + d) \times (d' - d) \times .78539$ &c.

IX. ELLIPSE.

If t = the semitransverse axis c = the semiconjugate, x any absciss, y the corresponding ordinate, and p the parameter; then

1. The ordinate $y = \frac{c}{t} \sqrt{(2xt - x^2)}$.
2. The Absciss $x = \pm \frac{t}{c} \sqrt{(c^2 - y^2)} + t$.
3. The semiconjugate $c = \frac{ty}{\sqrt{(2tx - x^2)}}$.
4. The semitransverse $t = \frac{cx}{y^2} \{c \pm \sqrt{(c^2 - y^2)}\}$.
5. The parameter $p = \frac{4c^2}{2t}$.

Making $1 - \frac{C^2}{t^2} = m$ and $C =$ circumference of circumscribing circle; then

1. The periphery $= C \times \{1 - \frac{m}{2^2} - \frac{3m^2}{2^2 \cdot 4^2} - \frac{3^2 \cdot 5m^3}{2^2 \cdot 4^2 \cdot 6^2} - \frac{3^2 \cdot 5^2 \cdot 7m^4}{2^2 \cdot 4^2 \cdot 6^2 \cdot 8^2} - \&c.\}$; or making $N = 3.14159 \&c$.
2. Periphery nearly $= N \times (t + c)$.
3. Periphery nearly $= N \times \sqrt{2(t^2 + c^2)}$.
4. Periphery very nearly $= \frac{1}{2}N\{t + c + \sqrt{2(t^2 + c^2)}\}$.

The letters still denoting the same things.

1. Area $= N \times t \times c$.
2. Area $= N \times t \times c \times \sin.$ of the angle of intersection; in this expression t and c are any pair of semiconjugate diameters.

Let t and c denote the semitransverse and semiconjugate axes respectively, and z the distance of the ordinate from the centre; then the elliptic arc bounded by the ordinate and parallel semiaxis will be

1. Elliptic arc $= z\{1 + \frac{c^2}{6t^4} z^2 + \frac{4t^2 c^2 - c^4}{40t^8} z^4 + \frac{8t^4 c^2 - 4t^2 c^4 + c^6}{112t^{12}} z^6 + \&c.\}$

Make $\frac{t^2 - c^2}{t^2} = q$; then

2. The arc nearly $= x \sqrt{\frac{t^2 - \frac{1}{3}q^2}{t^2 - \frac{1}{3}x^2}}$.

3. The arc nearly $= \frac{15pC + (19C - 21p)y}{15pC + (9C - 21p)y} \times x$.

C being the whole axis where the arc begins, and p , x , &c., the corresponding parameter, absciss, and ordinate.

X. ELLIPTIC SEGMENTS.

Find the area of the circular segment described on that axis to which the base of the segment is perpendicular, and call it x ; then

1. As this axis : the other axis :: x : the elliptic segment.

If the height of the segment be represented by h , and the vertical axis of the ellipse by v , and $\frac{h}{v} = q$; then

2. Elliptic segment $= tc \times$ tabular number answering to q in the table of circular segments, page 47.

XI. PARABOLA.

Let x = any absciss, y = the corresponding ordinate, and p the parameter; then

1. $p = \frac{y^2}{x}$. 2. $x = \frac{y^2}{p}$. 3. $y = \sqrt{px}$.

4. Area between x , y , and the curve $= \frac{2}{3}xy$.

XII. PARABOLIC ARCS.

Make $\frac{2y}{p} = q$, and $\sqrt{1 + q^2} = s$; then

1. Parabolic arc $= \frac{1}{2}p\{qs + \text{hyp. log. } (q + s)\}$.

2. Parabolic arc $= 2y\{1 + \frac{q^2}{2.3} - \frac{q^4}{2.4.5} + \frac{3q^6}{2.4.6.7} - \frac{3.5q^8}{2.4.6.8.9}$
+ &c.}

$$3. \text{ Parabolic arc} = 2y \left\{ 1 + \frac{q^2}{2.3} A - \frac{1.3q^2}{4.5} B + \frac{3.5q^2}{6.7} C - \&c. \right\}$$

where A, B, C, &c. denote the preceding terms. We have also

$$4. \text{ Parabolic arc nearly} = 2\sqrt{(y^2 + \frac{2}{3}x^2)}.$$

$$5. \text{ Parabolic arc nearly} = \frac{2}{3} \left\{ \sqrt{(y^2 + \frac{2}{3}x^2)} - \frac{y^2 + \frac{2}{3}x^2}{\frac{4}{3}y} \right\}.$$

XIII. PARABOLIC FRUSTUMS OR ZONES.

Let d' and d represent the two ends, and p the perpendicular distance between them; then

$$1. \text{ Area of zones} = \frac{2}{3}p \times \frac{d'^3 - d^3}{d'^2 - d^2}. \text{ And when } d = 0$$

$$2. \text{ Area} = \frac{2}{3}p \times d' \text{ for the whole parabola.}$$

XIV. HYPERBOLA.

Let t = the semitransverse diameter, c = the semiconjugate, x = any absciss, and y its corresponding ordinate; then

$$1. y = \frac{c}{t} \sqrt{(2tx + x^2)}. \quad 2. x = \pm \frac{t}{c} \sqrt{(c^2 + y^2)} - t.$$

$$3. c = \frac{ty}{\sqrt{(2tx + x^2)}}. \quad 4. t = \frac{cx}{y^2} \left\{ \sqrt{(c^2 + y^2)} \pm c \right\}.$$

XV. HYPERBOLIC ARCS.

Let y = the ordinate which limits the arc to be measured from the vertex, and t and c as before, and making

$$\frac{t^2 + c^2}{c^4} = q; \text{ hyp. log. } \frac{y + \sqrt{(c^2 + y^2)}}{c} = A, \text{ also}$$

$$\frac{1}{2} \{ y \sqrt{(c^2 + y^2)} - c^2 A \} = B.$$

$$\frac{1}{4} \{ y^3 \sqrt{(c^2 + y^2)} - 3c^2 B \} = C.$$

$$\frac{1}{8} \{ y^5 \sqrt{(c^2 + y^2)} - 5c^2 C \} = D.$$

&c. &c.; then

$$1. \text{Arc} = c \times \left\{ A + \frac{q}{2} B - \frac{q^2}{2.4} C + \frac{3q^3}{2.4.6} D - \frac{3.5q^4}{2.4.6.8} E + \&c. \right\}$$

$$2. \text{Arc} = y \times \left\{ 1 + \frac{t^2 y^2}{6c^4} - \frac{(t^4 + 4t^2 c^2) y^4}{40c^8} + \frac{(t^6 + 4t^4 c^2 + 8t^2 c^4) y^6}{112c^{12}} \right. \\ \left. - \frac{(5t^8 + 24t^6 c^2 + 48t^4 c^4 + 64t^2 c^6) y^8}{1152c^{16}} + \&c. \right\}$$

$$3. \text{Arc} = y \times \left\{ 1 + \frac{t^2 y^2}{6c^4} A - \frac{t^2 4c^2}{c^4} \times \frac{3y^2}{20} B + \frac{t^4 + 4t^2 c^2 + 8c^4}{t^2 + 4c^2} \right. \\ \left. \times \frac{5y^2}{14c^4} C - \frac{5t^6 + 24t^4 c^2 + 48t^2 c^4 + 64c^6}{t^4 + 4t^2 c^2 + 8c^4} \times \frac{7y^2}{72c^4} D + \&c. \right\}$$

In which last A, B, C, &c. are the preceding terms.

$$4. \text{Arc nearly} = \frac{30c^2 t + (19t^2 + 21c^2)x}{30c^2 t + (9t^2 + 21c^2)x} \times y.$$

XVI. HYPERBOLIC SEGMENTS.

Let $2y$ = the double ordinate which cuts off the segment, and z its distance from the centre, t , c , and x as before; then

$$1. \text{Hyp. seg. area} = zy - tc \times \text{hyp. log. } \frac{ty + cz}{tc}.$$

Making $\frac{x}{2t + x} = q$; then

$$2. \text{Hyp. seg. area} = 2xy \left\{ \frac{1}{3} - \frac{q}{1.3.5} - \frac{q^2}{3.5.7} - \frac{q^3}{5.7.9} - \&c. \right\}$$

$$3. \text{Hyp. seg. area} = 2xy \left(\frac{1}{3} - \frac{1}{3} Aq - \frac{1}{3} Bq - \frac{1}{3} Cq - \&c. \right)$$

where A, B, C, &c. represent the preceding terms.

$$4. \text{Area nearly} = \frac{4cx}{15t} \{ 4\sqrt{(2tx + \frac{3}{4}x^2)} + \sqrt{2tx} \}.$$

$$5. \text{Area nearly} = \frac{4cx}{75t} \left\{ 21\sqrt{(2tx + \frac{5}{4}x^2)} + 4\sqrt{2tx} \right\}.$$

XVII. HYPERBOLIC FRUSTUMS OR ZONES.

Let z' = the distance of a second double ordinate $2y'$, the rest as before; then

Area of the zone contained between $2y$ and $2y' = x'y' -$
 $- tc \times \text{hyp. log. of } \frac{ty' + cz'}{ty + cz}.$

XVIII. PRISMS AND CYLINDERS.

Let p = the perimeter of the base, a its area, and h height; then

1. Curve surface $= p \times h.$
2. Solidity $= a \times h.$ Formula also for oblique prisms cylinders.

XIX. PYRAMIDS AND CONES.

Let h' = the slant height, the rest as before; then

1. Curve surface $= \frac{1}{2}ph'.$
2. Solidity $= \frac{1}{3}ah.$ Formula also for oblique pyramids and cones.

XX. FRUSTUMS OF CONES AND PYRAMIDS.

Let a and $a' =$ the areas of the two ends, p and $p' =$ the perimeters, h the altitude, and h' the slant side; then

1. Curve surface $= \frac{1}{2}h'(p' + p).$
2. Solidity $= \frac{1}{3}h(a' + a) + \frac{1}{3}h\sqrt{a'} \times a.$

When the ends are circles, or regular polygons; putting d and d' for the diameters, c and c' for the circumferences (circles), or s and s' for the sides of the polygon, and T for tabular multiplier answering to the number of sides, Ta page 81; then

1. Solidity of conic frustum $= \frac{1}{3}h(d^2 + d'd + d'^2) \times .7854$
2. Solidity of conic frustum $= \frac{1}{3}h(c^2 + c'c + c'^2) \times .07958$
3. Solidity of pyram. frust. $= \frac{1}{3}h(s^2 + s's + s'^2) \times T.$

XXI. PRISMOIDS.

Let a' and $a =$ the areas of the two ends, a'' the area of the middle section, and $l =$ the length; then the

$$\text{Solidity} = \frac{1}{6}l(a + 4a'' + a').$$

XXII. WEDGE.

Let l = the length of the base, l' the length of the edge, b = the breadth of the base, and h the height of the wedge; then the solidity = $\frac{1}{6}hb(2l + l')$.

XXIII. SPHERE.

Let d = the diameter, c = the circumference, and s = the surface; then

$$1. \text{ Surface} = cd = 3.14159d^2 = .3183c^2.$$

$$2. \text{ Solidity} = \frac{1}{6}sd = .01688c^3 = .5236d^3.$$

XXIV. SPHERICAL SEGMENTS AND ZONES.

Let r = the radius of the base of the segment, h its height, and the rest as in the last; then

$$1. \text{ Surface of segment} = 3.14159dh.$$

$$2. \text{ Solidity} = .5236h(3r^2 + h^2).$$

$$3. \text{ Solidity} = .5236h(3d - 2h).$$

For the zones let r and r' = the radii of the two ends, and h = the altitude; then

$$4. \text{ Surface of zone} = 3.14159dh.$$

$$5. \text{ Solidity of zone} = 1.5708h(r^2 + r'^2 + \frac{1}{3}h^2).$$

XXV. CIRCULAR SPINDLE.

Let l = $\frac{1}{2}$ the length of the spindle, m = $\frac{1}{2}$ its middle diameter, a = the length of the generating arc, and a' the area of the generating segment, and make also $\frac{l^2 + m^2}{2m} = r$; then

$$1. \text{ Surface of spindle} = 2\{lr - a(r - m)\} \times 3.14159.$$

$$2. \text{ Solidity of spindle} = 4\{\frac{1}{3}l^3 - \frac{1}{2}a'(r - m)\} \times 3.14159.$$

For the middle zone of a circular spindle, let l = $\frac{1}{2}$ length of spindle, l' = $\frac{1}{2}$ length of the zone, a the generating area, and m and r as before; then

$$3. \text{ Solidity of zone} = 2\{(l^2 - \frac{1}{3}l'^2)l' - a(r - m)\} 3.14159.$$

XXVI. SPHEROID.

Let f = the fixed axis, and r = the revolving one, then making $\frac{f^2 \propto r^2}{f} = x$, we have

$$1. \text{ Surface of spheroid} = 3.14159fr(1 \pm \frac{Ax}{2.3} - \frac{3Bx}{4.5} \pm \frac{3.5Cx}{6.7}, \&c.)$$

using the upper signs for the oblong, and the under signs for the oblate spheroid, and putting A, B, C, &c. for the preceding terms. If we put $z = \frac{r}{f} s = \sqrt{(1 \propto z^2)}$, n = the

number of degrees, &c. of the arc of which s is the sine, $P = .01745329n$ in the oblong, and $P = 2.30285 \times \log. (s + z)$ in the oblate spheroid; then

$$2. \text{ The surface} = \frac{Pf + rs}{2s} \times 3.14159r.$$

$$3. \text{ Solidity} = \frac{1}{2}fr^2 \times 3.14159.$$

XXVII. FRUSTUMS OF SPHEROIDS.

Let f = the fixed, r = the revolving axis, and h = the height of the frustum; make also $\frac{f^2 \propto r^2}{f^2} = x$, and $\frac{4xh^2}{f^2} = z$;

then, if the frustum be cut off by two planes perpendicular to the fixed axis, and one of those planes pass through the centre of the spheroid,

$$1. \text{ Surface} = 3.14159rh(1 \pm \frac{Ax}{2.3} - \frac{3Bz}{4.5} \pm \frac{3.5Cs}{6.7} - \frac{5.7Ds}{8.9} \pm \&c.)$$

where A, B, C, &c. are the preceding terms; the upper signs being used for the oblate, and the under ones for the oblong spheroid.

Let d = diameter of the greater end, and d' = that of the less; then

$$2. \text{ Solidity} = \frac{1}{12}(2d^2 + d'^2)h \times 3.14159.$$

If the frustum be cut off by planes, one of which passes through the fixed axis, and the other parallel to it, then

if t = transverse, and c = conjugate axis of the greater end, and t' and c' for those of the less end,

$$3. \text{Solidity} = \frac{1}{2}(2tc + t'c')h \times 3.14159.$$

NOTE. For the whole middle frustum, the preceding results must be doubled.

XXVIII. SEGMENTS OF SPHEROIDS.

Let h = the height of the segment, f and r as in the preceding; then, when the base is parallel to the fixed axis,

$$1. \text{Solidity} = \frac{r^2}{f^2} (3r \oslash 2h)h^2 \times .5236.$$

And when the base is parallel to the revolving axis,

$$2. \text{Solidity} = \frac{r^2}{f^2} (3f \oslash 2h)h^2 \times .5236.$$

XXIX. ELLIPTIC SPINDLE.

Let l = length of spindle, a = the perpendicular axis of the ellipse, p = the parallel axis, c = the distance between the centre of ellipse and spindle, and g = the area of the generating segment; then

$$1. \text{Solidity} = 1.57078 \times \left(\frac{a^2 l^3}{3p^2} - 4cg \right).$$

And when d is the greatest diameter of the spindle, we have

$$2. \text{Solidity} = \frac{3}{2}l \times .7854 \{ d^2 - 4c \left(\frac{3g}{l} - d \right) \}.$$

XXX. PARABOLOIDS.

Let r = the radius of the circular base, and a the altitude of the solid; then

$$1. \text{Surface} = \frac{2 \times 3.14159r}{12a^2} \left\{ (r^2 + 4a^2)^{\frac{3}{2}} - r^3 \right\}.$$

$$2. \text{Solidity} = 3.14159 \times \frac{1}{2}r^2 a.$$

XXXI. FRUSTUMS OF PARABOLOIDS.

Let d = the greater diameter, d' = the less, p the parameter, and h = the height of the frustum; then, when the

base of the frustum is perpendicular to the axis of the paraboloid, we have

$$1. \text{ Surface} = \frac{(p^2 + d^2)^{\frac{3}{2}} - (p^2 + d'^2)^{\frac{3}{2}}}{p} \times \frac{1}{6} \times 3.14159.$$

$$2. \text{ Solidity} = .3927h(d^2 + d'^2), \text{ or when } d' = 0; \text{ then}$$

$$3. \text{ Solidity} = .3927hd^2 \text{ for the whole paraboloid.}$$

XXXII. PARABOLIC SPINDLE.

Let l = the length, and m = the middle diameter of the spindle; then

$$1. \text{ Solidity} = .418879lm^2.$$

Let d = the diameter of the end of the spindle, and we have for the middle frustum

$$2. \text{ Solidity} = .05236l(8m^2 + 3d^2 + 4dm).$$

XXXIII. HYPERBOLOIDS.

Let a and c = the semiaxis of the generating hyperboloid, v = the distance of its base from the centre. Also let z

$$= \frac{a^2}{\sqrt{(a^2 + c^2)}} \text{ be the semitransverse of another hyperbola,}$$

whose semiconjugate c , is the same as that of the former. Then find by the formula in XVII. the area of the frustum of this latter hyperbola, whose ends are distant from the centre by v and a , and multiply this area by 3.14159 for the surface; that is,

$$1. \text{ Surface} = 3.14159 \times (vy' - ay - zc \times \text{hyp. log. } \frac{zy' + cv}{zy + ac}),$$

where y' and y are the ordinates of the latter hyperbola, whose distances from the centre are v , and d .

$$2. \text{ Solidity} = 3.14159 \times \frac{1}{2}ar^2 \times \frac{t + \frac{3}{2}a}{t + a}, \text{ where } a = \text{the altitude, } r = \text{the radius of the base, and } t = \text{the transverse axis.}$$

Let d = the diameter in the middle between the base and the vertex; then

$$3. \text{ Solidity} = \frac{r^2 + d^2}{6} \times a \times 3.14159.$$

XXXIV. FRUSTUMS OF HYPERBOLOIDS.

Let d and d' = the semidiameters of the two ends, a = the altitude, and t and c = the transverse and conjugate axes ; then

1. Solidity = $3.14159 \times \frac{1}{2}a(d^2 + d'^2 - \frac{a^2 c^2}{3t^2})$.
2. Solidity = $3.14159 \times \frac{1}{6}a(d^2 + 4d''^2 + d'^2)$, where d'' is the middle diameter.

XXXV. HYPERBOLIC SPINDLE.

Let a = the generating area, d the greatest diameter, and l = the length of the spindle ; then

1. Solidity = $3.14159 \times \frac{1}{2} \left(\frac{(l^2 + d^2)a}{d} - \frac{1}{3}l^3 \right)$.
2. Solidity = $3.14159 \times \frac{1}{8}l \left(d^2 + \frac{(3a - ld)4c}{l} \right)$, where c is the central distance.

XXXVI. SPHERICAL LUNES.

Let d = diameter of sphere, b = greatest breadth of lune, or the arc which measures the distance of the two great circles between which the lune is comprised, s the whole surface of the sphere, and n the number of degrees in the angle of inclination of the two great circles ; then

1. Surface = $d \times b$, or

2. Surface = $\frac{\pi s}{360^\circ}$.

XXXVII. SPHERICAL TRIANGLES.

Let d = the diameter of the sphere, and s the sum of the three angles of the triangle ; then

$$\text{Surface of spherical triangle} = 3.14159 \times d^2 \times \frac{s - 180^\circ}{720^\circ}.$$

XXXVIII. SPHERICAL POLYGONS.

Let n = the number of the angles of the polygon, and d and s as in the last; then

$$\text{Surface of polygon} = 3.14159 \times d^2 \times \frac{s - 180(n - 2)}{720}.$$

XXXIX. CYLINDRICAL UNGULÆ.

I. When the plane passes through the base of the cylinder.

Let h = the altitude, b = the area of the base, $a = \frac{1}{2}$ the arc of the base s , c , v , respectively = the sine, cosine, and versine of $\frac{1}{2}$ the arc and d = the diameter of the cylinder; then

$$1. \text{ Curve surface of ungula} = \frac{(ds - ac)h}{v}.$$

$$2. \text{ Solidity of ungula} = \frac{(\frac{1}{3}s^3 - bc)h}{v}.$$

II. When the plane does not pass through the base.

$$1. \text{ Curve-surface} = \frac{1}{2}(h + h') \times 3.14159 \times d,$$

$$2. \text{ Solidity} = \frac{1}{2}(h + h') \times .78539 \times d^2,$$

$$3. \text{ Solidity} = \frac{1}{2}(h + h') \times .07958 \times c^2,$$

where h is the greatest height, h' the least height, and c the circumference of the cylinder.

XL. CONICAL UNGULÆ.

I. When the cutting plane passes through the opposite ends of the frustum.

Let d = diameter of greater end, d' = that of the less, and h = the altitude; then

$$1. \text{ Surface of the greater hoof} = \frac{.78539 \times \sqrt{\{4h^2 + (d - d')^2\}}}{d - d'} \times \left(d^2 - \frac{d + d'}{2} \sqrt{d \times d'}\right).$$

$$2. \text{ Surface of less hoof} = \frac{.78539 \times \sqrt{\{4h^2 + (d - d')^2\}}}{d - d'} \\ \times \left(\frac{d + d'}{2} \sqrt{d \times d'} - d'^2 \right).$$

$$3. \text{ Solid. gr. hoof} = \frac{d^2 - d' \sqrt{d \times d'}}{d - d'} \times \frac{1}{3} dh \times .78539.$$

$$4. \text{ Solid. of less hoof} = \frac{d \sqrt{d \times d'} - d'^2}{d - d'} \times \frac{1}{3} dh \times .78539.$$

$$5. \text{ Diff. of hoofs} \frac{(d^{\frac{3}{2}} - d'^{\frac{3}{2}})^2}{d - d'} \times \frac{1}{3} h \times .78539.$$

II. When the plane passes through any part of the base.

Let h' = the height of the segment forming the base of the ungula, A = the tabular segment whose versine is $\frac{h'}{d}$, B = that corresponding to $\frac{h' - d + d'}{d'}$, and the rest as before ; then

$$1. \text{ Sol. under hoof} = \left\{ A \times d^5 - B \times d'^5 \times \frac{h'^{\frac{3}{2}}}{(h' - d + d')^{\frac{3}{2}}} \right\} \\ \times \frac{\frac{1}{3} h}{d - d'}.$$

$$2. \text{ Sol. upper hoof} = \{ .78539 \times (d^5 - d'^5) - A d^5 + B d'^5 \\ + \frac{h'^{\frac{3}{2}}}{(h' - d + d')^{\frac{3}{2}}} \}$$

XLI. REGULAR BODIES.

Let s = the side, or edge, of one of the equal faces ; then

1. Surface = $s^2 \times$ tabular number answering to the body in Table, page 81.

2. Solidity = $s^3 \times$ tabular number answering to the body in Table, page 81.

AN EPITOME OF MECHANICS.

I. DESCENT OF BODIES IN FREE SPACE.

Let s represent the space fallen through in the time t , v the velocity acquired in that time, and $g = 16\frac{1}{2} = \frac{1}{2}$ the force of gravity in the latitude of London; then

$$\text{I. } s = gt^2 = \frac{v^2}{4g} = \frac{1}{2}tv. \quad \text{II. } v = 2gt = \frac{2s}{t} = 2\sqrt{gs}.$$

$$\text{III. } t = \frac{v}{2g} = \frac{2s}{v} = \sqrt{\frac{s}{g}}. \quad \text{IV. } g = \frac{v}{2t} = \frac{s}{t^2} = \frac{v^2}{4s}.$$

II. DESCENT DOWN INCLINED PLANES.

Let a represent the angle of inclination of the plane, and s its length; then $s \times \sin. a$ its height, and, substituting $g \times \sin. a$ instead of g in the preceding formulæ, we have

$$\text{I. } s = gt^2 \sin. a = \frac{v^2}{4g \sin. a} = \frac{1}{2}tv.$$

$$\text{II. } v = 2gt \sin. a = \frac{2s}{t} = 2\sqrt{gs \sin. a}.$$

$$\text{III. } t = \frac{v}{2g \sin. a} = \frac{2s}{v} = \sqrt{\frac{s}{g \sin. a}}.$$

$$\text{IV. } \sin. a = \frac{v}{2gt} = \frac{s}{gt^2} = \frac{v^2}{4gs}.$$

III. VIBRATIONS AND LENGTHS OF PENDULUMS.

Let $g = 16\frac{1}{2}$, $p = 3.14159$; the length of the seconds pendulum vibrating in very small arcs in that place $= l$, we have

$l = \frac{2g}{p^2}$; and as the lengths of pendulums are reciprocally as the squares of the times of vibrations, we have, for the length

of a pendulum vibrating once in t seconds in the same place,

$$l = \frac{2gt^2}{p^2}, \text{ and } t = p\sqrt{\frac{l}{2g}}.$$

This formula supposes an infinitely small arc; but if the arc is considerable, then, if v = the versine of half the arc of vibration, and d = the diameter of the arc described, or twice the length of the pendulum, we have

$$t = p\sqrt{\frac{l}{2g}} \times \left\{ 1 + \frac{1^2v}{2^2d} + \frac{1^2 \cdot 3^2v^2}{2^2 \cdot 4^2d^2} + \frac{1^2 \cdot 3^2 \cdot 5^2v^3}{2^2 \cdot 4^2 \cdot 6^2d^3} + \&c. \right\}$$

The time of revolution in a pendulum describing a conical surface is equal to the time of two oscillations of a simple pendulum, equal to the height of the cone, whatever may be the radius of its base.

IV. PROJECTILES IN FREE SPACE.

I. ON HORIZONTAL PLANES.

Let s , c , and t denote the sine, cosine, and tangent of the angle of elevation respectively; S the sine, and v the versine of twice the angle of elevation; R the horizontal range; T the time of flight; H the greatest height of the projectile $g = 32.2$ feet; and a the impetus or altitude due to V the velocity; then any two of these being given, the others may be found thus,

$$R = 2as = 4asc = \frac{SV^2}{g} = \frac{scV^2}{\frac{1}{2}g} = \frac{\frac{1}{2}gT^2}{s} = \frac{\frac{1}{2}gT^2}{t} = \frac{4H}{t}.$$

$$V = \sqrt{2ag} = \sqrt{\frac{gR}{s}} = \sqrt{\frac{gR}{2sc}} = \frac{\frac{1}{2}gT}{s} = \frac{2}{s} \sqrt{\frac{1}{2}gH}.$$

$$T = \frac{sV}{\frac{1}{2}g} = 2s\sqrt{\frac{a}{\frac{1}{2}g}} = \sqrt{\frac{tR}{\frac{1}{2}g}} = \sqrt{\frac{sR}{\frac{1}{2}gc}} = 2\sqrt{\frac{H}{\frac{1}{2}g}}.$$

$$H = as^2 = \frac{1}{2}av = \frac{1}{4}tR = \frac{sR}{4c} = \frac{s^2V^2}{2g} = \frac{vV^2}{4g} = \frac{1}{8}gT^2.$$

II. ON INCLINED PLANES.

Let c = cos. of direction above the horizon; C = cos. of inclination of the plane; s sine of direction above the plane; R the range in the oblique plane; T the time of flight; V

the projectile velocity; H the greatest height above the plane; a the impetus, or altitude due to the velocity V , and $g = 32.2$; then

$$R = \frac{cs}{C^2} 4a = \frac{2cs}{C^2 g} V^2 = \frac{gc}{2s} T^2 = \frac{4c}{s} H.$$

$$H = \frac{s^2}{C^2} a = \frac{s^2 V^2}{2gC^2} = \frac{sR}{4c} = \frac{g}{8} T^2.$$

$$V = \sqrt{2ag} = C \sqrt{\frac{gR}{2cs}} = \frac{gc}{2s} T = \frac{2C}{s} \sqrt{\frac{1}{2}gH}.$$

$$T = \frac{2s}{C} \sqrt{\frac{a}{\frac{1}{2}g}} = \frac{sV}{\frac{1}{2}gC} = \sqrt{\frac{sR}{\frac{1}{2}gc}} = 2 \sqrt{\frac{H}{\frac{1}{2}g}}.$$

Let v = the velocity of any shot or shell; B its weight, and C the weight of the charge of powder; then $v =$

$$1600 \sqrt{\frac{2C}{B}} = 2263 \sqrt{\frac{C}{B}} \text{ according to Dr Hutton's experi-}$$

ments; but according to Dr O. Gregory's experiments, on

$$\text{better powder } v = 1600 \sqrt{\frac{3C}{B}} = 2771 \sqrt{\frac{C}{B}}.$$

Let r = the range of a shot or shell at the elevation e , and R the range at another elevation E , then we have $\sin. 2e : \sin. 2E :: r : R$.

Also, if w = the charge of powder for the range r , and W the charge for the range R ; then $w : W :: r : R$.

V. CENTRE OF GRAVITY OF BODIES.

Let CO = the distance of the centre of gravity from the vertex, and a = the line joining the vertex with the middle of the base; then

$$\text{In a plane triangle,} \quad CO = \frac{2}{3}a.$$

$$\text{In a right cone or pyramid,} \quad CO = \frac{3}{4}a.$$

$$\text{In a circular arc, from the centre,} \quad CO = \frac{\text{chord} \times \text{radius}}{\text{arc}}$$

In a semicircle, from the centre,	$CO = \frac{4 \text{ radius}^2}{3 \text{ arc}}$
In a circular seg., from the centre,	$CO = \frac{\text{chord}^2}{12 \text{ area}}$
In a circular sector, from the centre	$CO = \frac{2 \text{ chord} \times \text{radius}}{3 \text{ arc}}$
In a parabola,	$CO = \frac{2}{3}a.$
In a segment of a sphere, from vertex	$CO = \frac{8 \text{ rad.} - 3a}{12 \text{ rad.} - 4a} a.$
In a semisphere or semispheroid,	$CO = \frac{5}{8}a.$
In paraboloid,	$CO = \frac{2}{3}a.$
In a hyperboloid,	$CO = \frac{4 \text{ axis} + 3a}{6 \text{ axis} + 4a} a.$

VI. THE CENTRE OF GYRATION.

Let CO = the distance of the centre of gyration from axis of motion ; then

In a right line or thin cylinder,	$CO = \text{length} \times \sqrt{\frac{1}{3}}.$
In the plane of a circle or cylinder revolving about the axis,	$CO = \text{rad.} \times \sqrt{\frac{1}{2}}.$
In the periphery of a circle revolving about its diameter,	$CO = \text{rad.} \times \sqrt{\frac{1}{2}}.$
In a wheel with a very thin rim revolving about its axle,	$CO = \text{radius}.$
In the plane of a circle about its diam.	$CO = \frac{1}{2} \text{ radius}.$
In the surface of a sphere about the diam.	$CO = \text{rad.} \times \sqrt{\frac{2}{3}}.$
In a globe revolving about the diam.	$CO = \text{rad.} \times \sqrt{\frac{2}{3}}.$
In a cone revolving about its axis,	$CO = \text{rad.} \times \sqrt{\frac{3}{10}}.$
In a lever whose arms are B and b ,	$CO = \sqrt{\frac{B^2 + b^2}{3B + 3b}}.$

VII. CENTRE OF OSCILLATION.

Let CO = the distance of the centre of oscillation from the point of suspension ; then

In a right line or cylinder, $CO = \frac{3}{8}$ of its length.

In an isosceles triangle suspended at its vertex, $CO = \frac{3}{4}$ of its altitude.

In a circle suspended at its circumference, $CO = \frac{1}{2}$ radius.

In a common parabola suspended at its vertex, $CO = \frac{1}{2}$ of its altitude.

In any parabola, $CO = \frac{2m+1}{3m+1} \times$ its altitude.

When the body vibrates laterally or sideways.

In a circle, $CO = \frac{3}{8}$ of its diameter.

In a rectangle suspended by one angle, $CO = \frac{2}{3}$ of its diagonal.

In a parabola suspended by its vertex, $CO = \frac{1}{2}$ axis + $\frac{1}{3}$ parameter.

In a parabola suspended by the middle of the base, $CO = \frac{1}{2}$ axis + $\frac{1}{2}$ parameter.

In a sector of a circle, $CO = \frac{3 \text{ arc} \times \text{radius}}{4 \text{ chord}}$.

In a cone, $CO = \frac{1}{2}$ axis + $\frac{(\text{radius of base})^2}{5 \text{ axis}}$.

In a sphere, $CO = \text{radius} + d + \frac{2 \text{ radius}^2}{5(d + \text{radius})}$

where d is the length of the thread by which it is suspended.

VIII. CENTRE OF PERCUSSION.

When the body revolves about a fixed point, the formulæ given for the *centre of oscillation* will answer for the centre of percussion; and when it moves in a straight line, or with a parallel motion, the formulæ are the same as those given for the *centre of gravity*.

IX. CONSTANT FORCES.

Let f and F , be any two constant accelerating forces acting on any body, during the times t and T , respectively, at the end

of which are generated the velocities v and V , and the spaces described are s and S ; then

$$1. \frac{s}{S} = \frac{tv}{TV} = \frac{t^2 f}{T^2 F} = \frac{v^2 F}{V^2 f} \quad 2. \frac{v}{V} = \frac{ft}{FT} = \frac{sT}{St} = \sqrt{\frac{fs}{FS}}$$

$$3. \frac{t}{T} = \frac{Fv}{fV} = \frac{sV}{Sv} = \sqrt{\frac{Fs}{fS}} \quad 4. \frac{f}{F} = \frac{Tv}{tV} = \frac{T^2 s}{t^2 S} = \frac{v^2 S}{V^2 s}$$

When one of the forces, as F , is gravity, and $T = 1''$, then $S = 16\frac{1}{2}$ feet $= g$, and $V = 32\frac{1}{2}$ feet $= 2g$, in which case these become

$$5. s = \frac{1}{2}tv = gft^2 = \frac{v^2}{4gf} \quad 6. v = \frac{2s}{t} = 2gft = 2\sqrt{gfs}$$

$$7. t = \frac{2s}{v} = \frac{v}{2gf} = \sqrt{\frac{s}{gf}} \quad 8. f = \frac{v}{2gt} = \frac{s}{gt^2} = \frac{v^2}{4gs}$$

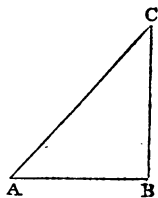
AN EPITOME OF TRIGONOMETRY.

I. SOLUTION OF RIGHT-ANGLED PLANE TRIANGLES.

I. Given any two variable parts of a plane right-angled triangle ABC , to find the other parts?

This problem divides itself into four distinct cases according to the different combination of the data; thus,

I. When the hypotenuse and a side are given.



II. When the two sides containing the right-angle are given.

III. When the hypotenuse and an angle are given.

IV. When either of the sides and an angle are given.

Case.	Given.	Sought.	Solution.
I.	AC and AB	A, or C, and BC.	$AC : AB :: R : \sin. C, \text{ or } \cos. A.$ $R : \sin. A :: AC : BC.$
II.	AB and BC	A, or C, and AC.	$AB : BC :: R : \tan. A, \text{ or } \cot. C.$ $\cos. A : R :: AB : AC, \text{ or }$ $R : \sec. A :: AB : AC.$
III.	AC and A	AB and BC	$R : \cos. A :: AC : AB.$ $R : \sin. A :: AC : BC.$
IV.	AB and A	BC and AC	$R : \tan. A :: AB : BC.$ $\cos. A : R :: AB : AC, \text{ or }$ $R : \sec. A :: AB : AC.$

In the first and second cases BC and AC may be readily deduced from the well known property of the right-angled triangle, viz. that the square of the hypotenuse is equal to the sum of the squares upon the other two sides; thus,

$BC^2 = AC^2 - AB^2 = (AC + AB) \times (AC - AB)$, consequently

$BC = \sqrt{\{(AC + AB) \times (AC - AB)\}}$,
and $AC^2 = AB^2 + BC^2$, or $AC = \sqrt{(AB^2 + BC^2)}$.

II. SOLUTION OF OBLIQUE-ANGLED PLANE TRIANGLES.

II. Given any three variable parts of an oblique-angled plane triangle, except the three angles, to find the others.

This problem includes three distinct cases, one of which is branched into two subordinate divisions; thus,

I. When the three sides are given.

II. 1. When two sides and the angle contained by them are given. 2. When two sides and the angle subtended by one of them is given.

III. When a side and two of the angles are given.

consideration, and of these the two sides, containing the right angle, and the *complements* of the angles and of the hypotenuse, are called the FIVE CIRCULAR PARTS.

When any one of these is taken as the MIDDLE PART, the two immediately adjacent on the right and left are called the ADJACENT PARTS; the other two, each separated from the middle part by an adjacent part, are called OPPOSITE PARTS.

With this arrangement of the different parts, the solution in every case is obtained by the two following equations:

1. $\text{Rad.} \times \sin. \text{ middle part} = \text{the rectangle of the tangents of the adjacent parts.}$

2. $\text{Rad.} \times \sin. \text{ middle part} = \text{the rectangle of the cosines of the opposite parts.}$

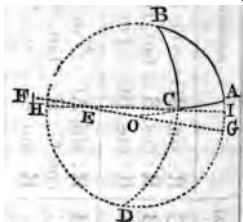
NOTE. In applying these equations to the solution of problems, take that, as the middle part, which is either adjacent to the other two given parts, or is separated from them by the remaining parts of the triangle, and form the equations according as the remaining parts are adjacent or opposite.

A *quadrantal triangle* may be changed into a right-angled triangle, by calling the supplement of the angle opposite to the quadrantal side, the hypotenuse; the other angles, the sides; the quadrantal side, radius; and the other sides, angles; but in the solution we must substitute *same* for *different affection* in the limitation.

IV. SOLUTION OF OBLIQUE-ANGLED SPHERICAL TRIANGLES.

When the three sides, or the three angles are not the given parts, the solution may always be obtained by drawing a perpendicular from the extremity of a given side, and opposite a given angle, and then computing by Napier's Rules of the circular Parts.

The Table, page 87, contains the proportions for the solution of the sixteen cases of any right-angled spherical triangle ABC.



The Table, pages 88 and 89, contains the proportions for the solutions of the twelve cases of oblique-angled spherical triangles, where ABC represents any spherical triangle in which the perpendicular AD either falls within the triangle or meets the base BC produced beyond C.

NOTE. The cases referred to are those of Table, page 87.

Given.	Sought.	Solution.	Equations.	Limitation.	Cases.
BC & B	AC	$R : \sin. BC :: \sin. B : \sin. AC.$	2	of the same affection with B. less than 90° , when BC and B are of the same affection. otherwise greater than 90° .	1
	AB	$R : \cos. B :: \tan. BC : \tan. BA.$	1		2
	C	$R : \cos. BC :: \tan. B : \cot. C.$	1		3
AC & C	AB	$R : \sin. AC :: \tan. C : \tan. AB.$	1	of the same affection with C. less than 90° , when AC and C are of the same affection. of the same affection with AC.	4
	BC	$\cos. C : R :: \tan. AC : \tan. BC.$	1		5
	B	$R : \sin. C :: \cos. AC : \cos. B.$	2		6
AC & B	AB	$\tan. B : \tan. AC :: R : \sin. AB.$	1	ambiguous; for two triangles may have the given things, but have the things sought in one of them the supplements of the things sought in the other.	7
	BC	$\sin. B : R :: \sin. AC : \sin. BC.$	2		8
	C	$\cos. AC : R :: \cos. B : \sin. C.$	2		9
AC & CB	AB	$\cos. AC : R :: \cos. BC : \cos. BA.$	2	less than 90° , if AC and CB be of the same affection. of the same affection with AC. less than 90° , if AC and CB be of the same affection.	10
	B	$\sin. BC : R :: \sin. AC : \sin. B.$	2		11
	C	$\tan. BC : \tan. AC :: R : \cos. C.$	1		12
AB & AC	BC	$R : \cos. AC :: \cos. AB : \cos. BC.$	2	less than 90° , if AB and AC be of the same affection. of the same affection with AC. of the same affection with AB.	13
	B	$\sin. AB : R :: \tan. AC : \tan. B.$	1		14
	C	$\sin. AC : R :: \tan. AB : \tan. C.$	1		14
B & C	AB	$\sin. B : R :: \cos. C : \cos. AB.$	2	of the same affection with C. of the same affection with B. less than 90° , if B and C be of the same affection.	15
	AC	$\sin. C : R :: \cos. B : \cos. AC.$	2		15
	BC	$\tan. B : \cot. C :: R : \cos. BC.$	1		16

Cases	Given	Sought.	Solution.
1	AB, AC, and B, opposite to AC.	C, the angle opposite to AB.	Sin. AC : sin. AB :: sin. B : sin. C. If the sum of BA, AC be less than 180°, and AB less than AC; the angle at C is acute; or, if the sum of BA, AC be greater than 180°, and AB greater than AC, ACB is obtuse. In other cases, ACB is ambiguous.
2	AB, AC, and B, opposite to AC.	BC, the third side.	R : cos. B :: tan. AB : tan. BD (case 2), and cos. AB : cos. AC :: cos. BD : cos. DC. When ABC is acute, DC, CA are of the same affection, otherwise they are of different affection. If CD be less than DB, but their sum not less than DB, their sum is CB; if CD be less than DB, but their sum not less than 180°, their difference is CB. In other cases, CB is ambiguous.
3	AB, AC, and B, opposite to AC.	A, the angle contained by the sides.	R : cos. AB :: tan. B : cot. BAD (case 3), and tan. AC : tan. AB :: cos. BAD : cos. DAC. If B be acute, DAC and AC are of the same affection, otherwise they are of different affection. If DAC be not less than BAD, their sum is BAC; if DAC be less than BAD, but their sum not less than 180°, their difference is BAC. In other cases, BAC is ambiguous.
4	B, C, and AB, two angles and the side opposite to one of them C.	AC, the side opposite to B.	Sin. C : sin. B :: sin. AB : sin. AC. If the sum of B and C be less than 180°, and B less than C, AC is acute; or if the sum of B and C be greater than 180°, and B greater than C, AC is obtuse. In other cases, AC is ambiguous.
5	B, C, and AB, two angles and the side opposite to one of them C.	A, the third angle.	R : cos. AB :: tan. B : cot. BAD (case 3), and cos. B : cos. C :: sin. BAD : sin. DAC, which is less than BAD, if B and C be of different affection, or less than the supplement of BAD, if B and C be of the same affection. In other cases it is ambiguous. When B and C are of the same affection, BAC is the sum of BAD, DAC, otherwise it is their difference.
6	B, C, and AB, two angles and the side opposite to one of them C.	BC, the third side.	R : cos. B :: tan. AB : tan. BD (case 2), and tan. C : tan. B :: sin. BD : sin. DC; and DC is less than DB, if B and C be of different affection, or

8	Given angle, AB, BC, and B, two sides and the included angle.	AC, the third side.	Find BD and DC as in the last case, then $\cos. BD : \cos. DC :: \cos. BA : \cos. AC$. If BD and DC be of the same affection, BA and AC are of the same affection; otherwise they are of different affection. Or add the sines of the two given sides, and twice the sine of half the contained angle, and from half the sum of these three logarithms subtract the sine of half the difference of the sides; the remainder is the tangent of an arc, whose sine taken from the half sum will leave the sine of half the required side.
9	A, B, and AB, two angles, and the included side.	C, the third angle.	$R \cos. AB :: \tan. B : \cot. BAD$ (case 3), and the difference of BAC, BAD, is DAC, then $\sin. BAD : \sin. DAC :: \cos. B : \cos. C$. If BAC be greater than BAD, B and C are of the same affection; otherwise they are of different affection.
10	A, B, and AB, two angles and the included side.	AC, one of the other sides.	Find BAD and DAC, as in the last case; then $\cos. DAC : \cos. BAD :: \tan. AB : \tan. AC$. If DAC and B be of the same affection, AC is less than 90°; otherwise it is greater than 90°.
11	AB, AC, and BC, the three sides.	B, one of the angles.	Let the perp. AD fall within, or be the nearest to B or C that falls without; then $\tan. \frac{1}{2} BC : \tan. \frac{1}{2} \text{sum of } BA, AC :: \tan. \frac{1}{2} \text{diff. of } BA, AC : \tan. \frac{1}{2} E$, and $\frac{1}{2} E$ added to $\frac{1}{2} BC$, gives the segment nearest the greater side, if the sum of AB, AC be less than 180°; otherwise it gives the segment nearest the less side. And $\tan. AB : \tan. BD :: R : \cos. B$ (case 12). Otherwise, Let D be $\frac{1}{2}$ the diff. of AB, BC; then the rect. $\sin. AB, \sin. BC : \text{rect. sin. sum and diff. of D and } \frac{1}{2} AC :: R^2 : \sin.^2 \frac{1}{2} B$. Otherwise, Let P be $\frac{1}{2}$ the perimeter; then $\text{rect. sin. AB, sin. BC : rect. sin. P. sin. diff. of P and AC} :: R^2 : \cos.^2 \frac{1}{2} B$.
12	A, B, and C, the three angles.	AC, one of the sides.	With the supplement of either of the angles A or C, and the measures of the other two angles, suppose a triangle made; and in it find the angle opposite to the side which is the measure of the angle at B, and the measure of the angle thus found is AC.

V. EQUIVALENT EXPRESSIONS FOR SINE A, COSINE A, A
TANGENT A.

1. Sine A = cos. A tan. A.
 2. = $\frac{\cos. A}{\cot. A}$.
 3. = $\sqrt{(1 + \cos.^2 A)}$.
 4. = $\frac{1}{\sqrt{(1 + \cot.^2 A)}}$ or = $\frac{1}{\operatorname{cosec.} A}$.
 5. = $\frac{\tan. A}{\sqrt{(1 + \tan.^2 A)}}$.
 6. = $2 \sin. \frac{1}{2}A \cos. \frac{1}{2}A$.
 7. = $\sqrt{\frac{1 - \cos. 2A}{2}}$.
 8. = $\frac{2 \tan. \frac{1}{2}A}{1 + \tan.^2 \frac{1}{2}A}$.
 9. = $\frac{2}{\cot. \frac{1}{2}A + \tan. \frac{1}{2}A}$.
 10. = $\frac{\sin. (30^\circ + A) - \sin. (30^\circ - A)}{\sqrt{3}}$.
 11. = $2 \sin.^2 (45^\circ + \frac{1}{2}A) - 1$.
 12. = $1 - 2 \sin.^2 (45^\circ - \frac{1}{2}A)$.
 13. = $\frac{1 - \tan.^2 (45^\circ - \frac{1}{2}A)}{1 + \tan.^2 (45^\circ - \frac{1}{2}A)}$.
 14. = $\frac{\tan. (45^\circ + \frac{1}{2}A) - \tan. (45^\circ - \frac{1}{2}A)}{\tan. (45^\circ + \frac{1}{2}A) + \tan. (45^\circ - \frac{1}{2}A)}$.
 15. = $\sin. (60^\circ + A) - \sin. (60^\circ - A)$.
-
16. Cosine A = $\frac{\sin. A}{\tan. A}$.
 17. = $\sin. A \cot. A$.

$$18. \text{Cosine } A = \sqrt{(1 - \sin.^2 A)}.$$

$$19. \dots\dots\dots = \frac{1}{\sqrt{(1 + \tan.^2 A)}}, \text{ or } = \frac{1}{\sec. A}.$$

$$20. \dots\dots\dots = \frac{\cot. A}{\sqrt{(1 + \cot.^2 A)}}.$$

$$21. \dots\dots\dots = \cos.^2 \frac{1}{2} A - \sin.^2 \frac{1}{2} A.$$

$$22. \dots\dots\dots = 1 - 2 \sin.^2 \frac{1}{2} A.$$

$$23. \dots\dots\dots = 2 \cos.^2 \frac{1}{2} A - 1.$$

$$24. \dots\dots\dots = \sqrt{\frac{1 + \cos. 2A}{2}}.$$

$$25. \dots\dots\dots = \frac{1 - \tan.^2 \frac{1}{2} A}{1 + \tan.^2 \frac{1}{2} A}.$$

$$26. \dots\dots\dots = \frac{\cot. \frac{1}{2} A - \tan. \frac{1}{2} A}{\cot. \frac{1}{2} A + \tan. \frac{1}{2} A}.$$

$$27. \dots\dots\dots = \frac{1}{1 + \tan. A \tan. \frac{1}{2} A}.$$

$$28. \dots\dots\dots = \frac{2}{\tan. (45^\circ + \frac{1}{2} A) + \cot. (45^\circ + \frac{1}{2} A)}.$$

$$29. \dots\dots\dots = 2 \cos. (45^\circ + \frac{1}{2} A) \cos. (45^\circ \smile \frac{1}{2} A).$$

$$30. \dots\dots\dots = \cos. (60^\circ + A) + \cos. (60^\circ \smile A).$$

$$31. \text{Tangent } A = \frac{\sin. A}{\cos. A}.$$

$$32. \dots\dots\dots = \frac{1}{\cot. A}.$$

$$33. \dots\dots\dots = \sqrt{\left(\frac{1}{\cos. A} - 1\right)}.$$

$$34. \dots\dots\dots = \frac{\sin. A}{\sqrt{(1 - \sin.^2 A)}}.$$

$$35. \dots\dots\dots = \frac{(\sqrt{1 - \cos.^2 A})}{\cos. A}.$$

$$36. \text{ Tangent } A = \frac{2 \tan. \frac{1}{2} A}{1 - \tan.^2 \frac{1}{2} A}.$$

$$37. \dots\dots\dots = \frac{2 \cot. \frac{1}{2} A}{\cot.^2 \frac{1}{2} A - 1}.$$

$$38. \dots\dots\dots = \frac{2}{\cot. \frac{1}{2} A - \tan. \frac{1}{2} A}.$$

$$39. \dots\dots\dots = \cot. A - 2 \cot. 2A.$$

$$40. \dots\dots\dots = \frac{1 - \cos. 2A}{\sin. 2A}.$$

$$41. \dots\dots\dots = \frac{\sin. 2A}{1 + \cos. 2A}.$$

$$42. \dots\dots\dots = \sqrt{\frac{1 - \cos. 2A}{1 + \cos. 2A}}.$$

$$43. \dots\dots\dots = \frac{\tan. (45^\circ + \frac{1}{2} A) - \tan. (45^\circ - \frac{1}{2} A)}{2}.$$

VI. ANALYTICAL FORMULÆ FOR SOLVING THE VARIOUS CASES OF A RECTILINEAL TRIANGLE ABC, OF WHICH THREE PARTS ARE GIVEN.

$$1. AB = \frac{BC \sin. C}{\sin. A}.$$

$$2. \dots = \frac{AC \sin. C}{\sin. B}.$$

$$3. \dots = \frac{BC}{\cos. B + \sin. B \cot. C}.$$

$$4. \dots = \frac{AC}{\cos. A + \sin. A \cot. C}.$$

$$5. \dots = BC \cos. B + BC \sin. B \cot. A.$$

$$6. \dots = AC \cos. A + AC \sin. A \cot. B.$$

$$7. \dots = \sqrt{(BC^2 + AC^2 - 2BC \times AC \cos. C)}.$$

$$8. AB = BC \cos. B \pm \sqrt{(AC^2 - BC^2 \sin.^2 B)}.$$

$$9. \dots = AC \cos. A \pm \sqrt{(BC^2 - AC^2 \sin.^2 A)}.$$

$$10. AC = \frac{AB \sin. B}{\sin. C}.$$

$$11. \dots = \frac{BC \sin. B}{\sin. A}.$$

$$12. \dots = \frac{AB}{\cos. A + \sin. A \cot. B}.$$

$$13. \dots = \frac{BC}{\cos. C + \sin. C \cot. B}.$$

$$14. \dots = AB \cos. A + AB \sin. A \cot. C.$$

$$15. \dots = BC \cos. C + BC \sin. C \cot. A.$$

$$16. \dots = \sqrt{(BC^2 + AB^2 - 2BC \times AB \cos. B)}.$$

$$17. \dots = AB \cos. A \pm \sqrt{(BC^2 - AB^2 \sin.^2 A)}.$$

$$18. \dots = BC \cos. C \pm \sqrt{(AB^2 - BC^2 \sin.^2 C)}.$$

$$19. BC = \frac{AC \sin. A}{\sin. B}.$$

$$20. \dots = \frac{AB \sin. A}{\sin. C}.$$

$$21. \dots = \frac{AC}{\cos. C + \sin. C \cot. A}.$$

$$22. \dots = \frac{AB}{\cos. B + \sin. B \cot. A}.$$

$$23. \dots = AC \cos. C + AC \sin. C \cot. B.$$

$$24. \dots = AB \cos. B + AB \sin. B \cot. C.$$

$$25. \dots = \sqrt{(AB^2 + AC^2 - 2AB \times AC \cos. A)}.$$

$$26. BC = AC \cos. C \pm \sqrt{(AB^2 - AC^2 \sin.^2 C)}.$$

$$27. . . = AB \cos. B \pm \sqrt{(AC^2 - AB^2 \sin.^2 B)}.$$

$$28. \text{Sine } A = \frac{BC \sin. C}{AB}.$$

$$29. . . . = \frac{BC \sin. B}{AC}.$$

$$30. . . . = \sin. (B + C).$$

$$31. . . . = \sin. B \cos. C + \cos. B \sin. C.$$

$$32. . . . = \frac{BC \sin. C}{\sqrt{(BC^2 + AC^2 - 2BC \times AC \cos. C)}}.$$

$$33. . . . = \frac{BC \sin. B}{\sqrt{(BC^2 + AB^2 - 2BC \times AB \cos. B)}}.$$

$$34. . . . = \sqrt{\left\{1 - \left(\frac{AB^2 + AC^2 - BC^2}{2AB \times AC}\right)^2\right\}}.$$

$$35. . . . = \frac{\sin. C \{AC \cos. C \pm \sqrt{(AB^2 - AC^2 \sin.^2 C)}\}}{AB}.$$

$$36. . . . = \frac{\sin. B \{AB \cos. B \pm \sqrt{(AC^2 - AB^2 \sin.^2 B)}\}}{AC}.$$

$$37. \text{Cosine } A = \frac{\pm \sqrt{(AB^2 - BC^2 \sin.^2 C)}}{AB}.$$

$$38. = \frac{\pm \sqrt{(AC^2 - BC^2 \sin.^2 B)}}{AC}.$$

$$39. = -\cos. (B + C).$$

$$40. = \sin B \sin. C - \cos. B \cos. C.$$

$$41. = \frac{AC - BC \cos. C}{\sqrt{(BC^2 + AC^2 - 2BC \times AC \cos. C)}}.$$

$$42. \text{ Cosine } A = \frac{AB - BC \cos. B}{\sqrt{(BC^2 + AB^2 - 2BC \times AB \cos. B)}}$$

$$43. \dots\dots = \frac{AB^2 + AC^2 - BC^2}{2AB \times AC}.$$

$$44. \dots\dots = \frac{AC \sin.^2 C \mp \cos. C \sqrt{(AB^2 - AC^2 \sin.^2 C)}}{AB}$$

$$45. \dots\dots = \frac{AB \sin.^2 B \mp \cos. B \sqrt{(AC^2 - AB^2 \sin.^2 B)}}{AC}$$

$$46. \text{ Tangent } A = \frac{BC \sin. C}{\pm \sqrt{(AB^2 - BC^2 \sin.^2 C)}}$$

$$47. \dots\dots = \frac{BC \sin. B}{\pm \sqrt{(AC^2 - BC^2 \sin.^2 B)}}$$

$$48. \dots\dots = -\tan. (B + C).$$

$$49. \dots\dots = \frac{\tan. B + \tan. C}{\tan. B \tan. C - 1}.$$

$$50. \dots\dots = \frac{BC \sin. C}{AC - BC \cos. C}$$

$$51. \dots\dots = \frac{BC \sin. B}{AB - BC \cos. B}$$

$$52. \dots\dots = \pm \sqrt{\left\{ \left(\frac{2AB \times AC}{AB^2 + AC^2 - BC^2} \right)^2 - 1 \right\}}.$$

$$53. \dots\dots = \frac{AC \cos. C \pm \sqrt{(AB^2 - AC^2 \sin.^2 C)}}{AC \sin. C \mp \cot. C \sqrt{(AB^2 - AC^2 \sin.^2 C)}}$$

$$54. \dots\dots = \frac{AB \cos. B \pm \sqrt{(AC^2 - AB^2 \sin.^2 B)}}{AB \sin. B \mp \cot. B \sqrt{(AC^2 - AB^2 \sin.^2 B)}}$$

$$55. \text{ Sine } B = \frac{AC \sin. A}{BC}.$$

$$56. \dots\dots = \frac{AC \sin. C}{AB}.$$

$$57. \dots\dots = \sin. (A + C).$$

$$58. \text{ Sine } B = \sin. A \cos. C + \cos. A \sin. C.$$

$$59. \dots = \frac{AC \sin. A}{\sqrt{(AB^2 + AC^2 - 2AB \times AC \cos. A)}} \quad \text{Tangent } A$$

$$60. \dots = \frac{AC \sin. C}{\sqrt{(BC^2 + AC^2 - 2BC \times AC \cos. C)}} \quad \text{Cosine } A$$

$$61. \dots = \sqrt{\left\{1 - \left(\frac{BC^2 + AB^2 - AC^2}{2BC \times AB}\right)^2\right\}}.$$

$$62. \dots = \frac{\sin. A \{AB \cos. A \pm \sqrt{(BC^2 - AB^2 \sin.^2 A)}\}}{BC}$$

$$63. \dots = \frac{\sin. C \{BC \cos. C \pm \sqrt{(AB^2 - BC^2 \sin.^2 C)}\}}{AB}$$

$$64. \text{ Cosine } B = \frac{\pm \sqrt{(BC^2 - AC^2 \sin.^2 A)}}{BC}$$

$$65. \dots = \frac{\pm \sqrt{(AB^2 - AC^2 \sin.^2 C)}}{AB}$$

$$66. \dots = -\cos. (A + C).$$

$$67. \dots = \sin. A \sin. C - \cos. A \cos. C.$$

$$68. \dots = \frac{AB - AC \cos. A}{\sqrt{(AB^2 + AC^2 - 2AB \times AC \cos. A)}}$$

$$69. \dots = \frac{BC - AC \cos. C}{\sqrt{(BC^2 + AC^2 - 2BC \times AC \cos. C)}}$$

$$70. \dots = \frac{BC^2 + AB^2 - AC^2}{2BC \times AB}$$

$$71. \dots = \frac{AB \sin.^2 A \mp \cos. C \sqrt{(BC^2 - AB^2 \sin.^2 A)}}{BC}$$

$$72. \dots = \frac{BC \sin.^2 C \mp \cos. C \sqrt{(AB^2 - BC^2 \sin.^2 C)}}{AB}$$

$$73. \text{ Tangent } B = \frac{AC \sin. A}{\pm \sqrt{(BC^2 - AC^2 \sin.^2 A)}}$$

$$74. \text{ Tangent } B = \frac{AC \sin. C}{\pm \sqrt{(AB^2 - AC^2 \sin.^2 C)}}$$

$$75. \dots = -\tan. (A + C).$$

$$76. \dots = \frac{\tan. A + \tan. C}{\tan. A \tan. C - 1}.$$

$$77. \dots = \frac{AC \sin. A}{AB - AC \cos. A}.$$

$$78. \dots = \frac{AC \sin. C}{BC - AC \cos. C}.$$

$$79. \dots = \pm \sqrt{\left\{ \left(\frac{2BC \times AB}{BC^2 + AB^2 - AC^2} \right)^2 - 1 \right\}}.$$

$$80. \dots = \frac{AB \cos. A \pm \sqrt{(BC^2 - AB^2 \sin.^2 A)}}{AB \sin. A \mp \cot. A \sqrt{(BC^2 - AB^2 \sin.^2 A)}}.$$

$$81. \dots = \frac{BC \cos. C \pm \sqrt{(AB^2 - BC^2 \sin.^2 C)}}{BC \sin. C \mp \cot. C \sqrt{(AB^2 - BC^2 \sin.^2 C)}}.$$

$$82. \text{ Sine } C = \frac{AB \sin. B}{AC}.$$

$$83. \dots = \frac{AB \sin. A}{BC}.$$

$$84. \dots = \sin. (A + B).$$

$$85. \dots = \sin. A \cos. B + \cos. A \sin. B.$$

$$86. \dots = \frac{AB \sin. B}{\sqrt{(BC^2 + AB^2 - 2BC \times AB \cos. B)}}.$$

$$87. \dots = \frac{AB \sin. A}{\sqrt{(AB^2 + AC^2 - 2AB \times AC \cos. A)}}.$$

$$88. \dots = \sqrt{\left\{ 1 - \left(\frac{BC^2 + AC^2 - AB^2}{2BC \times AC} \right)^2 \right\}}.$$

$$89. \dots = \frac{\sin. B \{ B \cos. BC \pm \sqrt{(AC^2 - BC^2 \sin.^2 B)} \}}{AC}.$$

$$90. \text{ Sine } C = \frac{\sin. A \{ AC \cos. A \pm \sqrt{(BC^2 - AC^2 \sin.^2 A)} \}}{BC}$$

$$91. \text{ Cosine } C = \frac{\pm \sqrt{(AC^2 - AB^2 \sin.^2 B)}}{AC}$$

$$92. \dots = \frac{\pm \sqrt{(BC^2 - AB^2 \sin.^2 A)}}{BC}$$

$$93. \dots = -\cos. (A + B).$$

$$94. \dots = \sin. A \sin. B - \cos. A \cos. B.$$

$$95. \dots = \frac{BC - AB \cos. B}{\sqrt{(BC^2 + AB^2 - 2BC \times AB \cos. B)}}$$

$$96. \dots = \frac{AC - AB \cos. A}{\sqrt{(AB^2 + AC^2 - 2AB \times AC \cos. A)}}$$

$$97. \dots = \frac{BC^2 + AC^2 - AB^2}{2BC \times AC}$$

$$98. \dots = \frac{BC \sin.^2 B \mp \cos. B \sqrt{(AC^2 - BC^2 \sin.^2 A)}}{AC}$$

$$99. \dots = \frac{AC \sin.^2 A \mp \cos. A \sqrt{(BC^2 - AC^2 \sin.^2 A)}}{BC}$$

$$100. \text{ Tangent } C = \frac{AB \sin. B}{\pm \sqrt{(AC^2 - AB^2 \sin.^2 B)}}$$

$$101. \dots = \frac{AB \sin. A}{\pm \sqrt{(BC^2 - AB^2 \sin.^2 A)}}$$

$$102. \dots = -\tan. (A + B).$$

$$103. \dots = \frac{\tan. A + \tan. B}{\tan. A \tan. B - 1}$$

$$104. \dots = \frac{AB \sin. B}{BC - AB \cos. B}$$

$$105. \text{ Tangent } C = \frac{AB \sin. A}{AC - AB \cos. A}$$

$$106. \dots\dots\dots = \pm \sqrt{\left\{ \left(\frac{2BC \times AC}{BC^2 + AC^2 - AB^2} \right)^2 - 1 \right\}}.$$

$$107. \dots\dots\dots = \frac{BC \cos. B \pm \sqrt{(AC^2 - BC^2 \sin.^2 B)}}{BC \sin. B \mp \cot. B \sqrt{(AC^2 - BC^2 \sin.^2 B)}}.$$

$$108. \dots\dots\dots = \frac{AC \cos. A \pm \sqrt{(BC^2 - AC^2 \sin.^2 A)}}{AC \sin. A \mp \cot. A \sqrt{(BC^2 - AC^2 \sin.^2 A)}}.$$

VII. ANALYTICAL FORMULÆ FOR SOLVING THE DIFFERENT
CASES OF A SPHERICAL TRIANGLE ABC.

$$1. \text{ Sin. } A = \frac{\sin. BC \sin. C}{\sin. AB}.$$

$$2. \text{ Sin. } A = \frac{\sin. BC \sin. B}{\sin. AC}.$$

$$3. \text{ Sin. } B = \frac{\sin. AC \sin. A}{\sin. BC}.$$

$$4. \text{ Sin. } B = \frac{\sin. AC \sin. C}{\sin. AB}.$$

$$5. \text{ Sin. } C = \frac{\sin. AB \sin. B}{\sin. AC}.$$

$$6. \text{ Sin. } C = \frac{\sin. AB \sin. A}{\sin. BC}.$$

$$7. \text{ Cos. } A = \frac{\cos. BC - \cos. AB \cos. AC}{\sin. AB \sin. AC}.$$

$$8. \text{ Cos. } A = \cos. BC \sin. B \sin. C - \cos. B \cos. C.$$

$$9. \text{ Cos. } B = \frac{\cos. AC - \cos. BC \cos. AB}{\sin. BC \sin. AB}.$$

$$10. \text{ Cos. } B = \cos. AC \sin. A \sin. C - \cos. A \cos. C.$$

11. $\text{Cos. } C = \frac{\text{cos. } AB - \text{cos. } BC \text{ cos. } AC}{\text{sin. } BC \text{ sin. } AC}.$
12. $\text{Cos. } C = \text{cos. } AB \text{ sin. } A \text{ sin. } B - \text{cos. } A \text{ cos. } B.$
13. $\text{Tan. } A = \frac{\text{sin. } B}{\text{sin. } AB \text{ cot. } BC - \text{cos. } AB \text{ cos. } B}.$
14. $\text{Tan. } A = \frac{\text{sin. } C}{\text{sin. } AC \text{ cot. } BC - \text{cos. } AC \text{ cos. } C}.$
15. $\text{Tan. } B = \frac{\text{sin. } C}{\text{sin. } BC \text{ cot. } AC - \text{cos. } BC \text{ cos. } C}.$
16. $\text{Tan. } B = \frac{\text{sin. } A}{\text{sin. } AB \text{ cot. } AC - \text{cos. } AB \text{ cos. } A}.$
17. $\text{Tan. } C = \frac{\text{sin. } A}{\text{sin. } AC \text{ cot. } AB - \text{cos. } AC \text{ cos. } A}.$
18. $\text{Tan. } C = \frac{\text{sin. } B}{\text{sin. } BC \text{ cot. } AB - \text{cos. } BC \text{ cos. } B}.$
19. $\text{Sin. } BC = \frac{\text{sin. } AB \text{ sin. } A}{\text{sin. } C}.$
20. $\text{Sin. } BC = \frac{\text{sin. } AC \text{ sin. } A}{\text{sin. } B}.$
21. $\text{Sin. } AC = \frac{\text{sin. } BC \text{ sin. } B}{\text{sin. } A}.$
22. $\text{Sin. } AC = \frac{\text{sin. } AB \text{ sin. } B}{\text{sin. } C}.$
23. $\text{Sin. } AB = \frac{\text{sin. } AC \text{ sin. } C}{\text{sin. } B}.$
24. $\text{Sin. } AB = \frac{\text{sin. } BC \text{ sin. } C}{\text{sin. } A}.$
25. $\text{Cos. } BC = \frac{\text{cos. } A + \text{cos. } B \text{ cos. } C}{\text{sin. } B \text{ sin. } C}.$
26. $\text{Cos. } BC = \text{cos. } A \text{ sin. } AB \text{ sin. } AC + \text{cos. } AB \text{ cos. } C.$

- $$27. \cos. AC = \frac{\cos. B + \cos. A \cos. C}{\sin. A \sin. C}.$$
- $$28. \cos. AC = \cos. B \sin. BC \sin. AB + \cos. BC \cos. AB.$$
- $$29. \cos. AB = \frac{\cos. C + \cos. A \cos. B}{\sin. A \sin. B}.$$
- $$30. \cos. AB = \cos. C \sin. BC \sin. AC + \cos. BC \cos. AC.$$
- $$31. \tan. BC = \frac{\sin. AB}{\sin. B \cot. A + \cos. B \cos. AB}.$$
- $$32. \tan. BC = \frac{\sin. AC}{\sin. C \cot. A + \cos. C \cos. AC}.$$
- $$33. \tan. AC = \frac{\sin. BC}{\sin. C \cot. B + \cos. C \cos. BC}.$$
- $$34. \tan. AC = \frac{\sin. AB}{\sin. A \cot. B + \cos. A \cos. AB}.$$
- $$35. \tan. AB = \frac{\sin. AC}{\sin. A \cot. C + \cos. A \cos. AC}.$$
- $$36. \tan. AB = \frac{\sin. BC}{\sin. B \cot. C + \cos. B \cos. BC}.$$

VIII. FORMULE RELATIVE TO TWO ARCS OR ANGLES.

1. $\sin. (A+B) = \sin. A \cos. B + \cos. A \sin. B.$
2. $\sin. (A-B) = \sin. A \cos. B - \cos. A \sin. B.$
3. $\cos. (A+B) = \cos. A \cos. B - \sin. A \sin. B.$
4. $\cos. (A-B) = \cos. A \cos. B + \sin. A \sin. B.$
5. $\tan. (A+B) = \frac{\tan. A + \tan. B}{1 - \tan. A \tan. B}.$
6. $\tan. (A-B) = \frac{\tan. A - \tan. B}{1 + \tan. A \tan. B}.$

$$7. \frac{\sin. (A + B)}{\sin. (A - B)} = \frac{\tan. A + \tan. B}{\tan. A - \tan. B} = \frac{\cot. B + \cot. A}{\cot. B - \cot. A}.$$

$$8. \frac{\cos. (A + B)}{\cos. (A - B)} = \frac{\cot. B - \tan. A}{\cot. B + \tan. A} = \frac{\cot. A - \tan. B}{\cot. A + \tan. B}.$$

$$9. \frac{\sin. A + \sin. B}{\sin. A - \sin. B} = \frac{\tan. \frac{1}{2}(A + B)}{\tan. \frac{1}{2}(A - B)}.$$

$$10. \frac{\cos. B + \cos. A}{\cos. B - \cos. A} = \frac{\cot. \frac{1}{2}(A + B)}{\tan. \frac{1}{2}(A - B)}.$$

$$11. \sin. A \cos. B = \frac{1}{2} \sin. (A + B) + \frac{1}{2} \sin. (A - B).$$

$$12. \cos. A \sin. B = \frac{1}{2} \sin. (A + B) - \frac{1}{2} \sin. (A - B).$$

$$13. \sin. A \sin. B = \frac{1}{2} \cos. (A - B) - \frac{1}{2} \cos. (A + B).$$

$$14. \cos. A \cos. B = \frac{1}{2} \cos. (A + B) + \frac{1}{2} \cos. (A - B).$$

$$15. \sin. A + \sin. B = 2 \sin. \frac{1}{2}(A + B) \cos. \frac{1}{2}(A - B).$$

$$16. \cos. A + \cos. B = 2 \cos. \frac{1}{2}(A + B) \cos. \frac{1}{2}(A - B).$$

$$17. \tan. A + \tan. B = \frac{\sin. (A + B)}{\cos. A \cos. B}.$$

$$18. \cot. A + \cot. B = \frac{\sin. (A + B)}{\sin. A \sin. B}.$$

$$19. \sin. A - \sin. B = 2 \sin. \frac{1}{2}(A - B) \cos. \frac{1}{2}(A + B).$$

$$20. \cos. B - \cos. A = 2 \sin. \frac{1}{2}(A - B) \sin. \frac{1}{2}(A + B).$$

$$21. \tan. A - \tan. B = \frac{\sin. (A - B)}{\cos. A \cos. B}.$$

$$22. \cot. B - \cot. A = \frac{\sin. (A - B)}{\sin. A \sin. B}.$$

11	11
21	21
31	31
41	41
51	51
61	61
71	71
81	81
91	91
01	01

1. 1000
2. 1000
3. 1000
4. 1000
5. 1000
6. 1000
7. 1000
8. 1000
9. 1000
10. 1000

THE LOGARITHMS OF NUMBERS

FROM 1 TO 10,000.

Numbers from 1 to 100 and their Logarithms, with their Indices.

No.	Log.	No.	Log.	No.	Log.	No.	Log.	No.	Log.
1	0.000000	21	1.322219	41	1.612784	61	1.785330	81	1.908485
2	0.301030	22	1.342423	42	1.623249	62	1.792392	82	1.913814
3	0.477121	23	1.361728	43	1.633468	63	1.799341	83	1.919078
4	0.602060	24	1.380211	44	1.643453	64	1.806180	84	1.924279
5	0.698970	25	1.397940	45	1.653213	65	1.812913	85	1.929419
6	0.778151	26	1.414973	46	1.662758	66	1.819544	86	1.934498
7	0.845098	27	1.431364	47	1.672098	67	1.826075	87	1.939519
8	0.903090	28	1.447158	48	1.681241	68	1.832509	88	1.944483
9	0.954243	29	1.462398	49	1.690196	69	1.838849	89	1.949390
10	1.000000	30	1.477121	50	1.698970	70	1.845098	90	1.954243
11	1.041393	31	1.491362	51	1.707570	71	1.851258	91	1.959041
12	1.079181	32	1.505150	52	1.716003	72	1.857332	92	1.963788
13	1.113943	33	1.518514	53	1.724276	73	1.863323	93	1.968483
14	1.146128	34	1.531479	54	1.732394	74	1.869232	94	1.973128
15	1.176091	35	1.544068	55	1.740363	75	1.875061	95	1.977724
16	1.204120	36	1.556303	56	1.748188	76	1.880814	96	1.982271
17	1.230449	37	1.568202	57	1.755875	77	1.886491	97	1.986772
18	1.255273	38	1.579784	58	1.763428	78	1.892095	98	1.991226
19	1.278754	39	1.591065	59	1.770852	79	1.897627	99	1.995635
20	1.301030	40	1.602060	60	1.778151	80	1.903090	100	2.000000

NOTE. In the following part of the Table the Indices are omitted, as they can be very easily supplied by the directions given in the Section on Logarithms, page 9.

N.	0	1	2	3	4	5	6	7	8	9
100	000000	000434	000868	001301	001734	002168	002598	003029	003461	003893
1	4321	4751	5181	5609	6038	6466	6894	7321	7748	8175
2	8600	9026	9451	9876	010300	010724	011147	011570	011993	012416
3	012837	013259	013680	014100	4521	4940	5360	5779	6197	6615
4	7033	7451	7868	8284	8700	9116	9532	9947	020367	020781
5	021189	021603	022016	022428	022841	023252	023664	024075	4486	4897
6	5306	5715	6125	6533	6942	7350	7757	8164	8571	8978
7	9384	9789	030195	030600	031004	031408	031812	032216	032619	033023
8	033424	033826	4227	4628	5029	5430	5830	6230	6629	7028
9	7426	7825	8223	8620	9017	9414	9811	040207	040602	041000
110	041393	041787	042182	042576	042969	043362	043755	044148	044540	044933
1	5323	5714	6105	6495	6885	7275	7664	8053	8442	8831
2	9218	9606	9993	050380	050766	051153	051538	051924	052309	052694
3	053076	053463	053846	4230	4613	4996	5378	5760	6142	6523
4	6905	7286	7666	8046	8426	8805	9185	9563	9942	060000
5	060698	061075	061452	061829	062206	062582	062958	063333	063709	44
6	4458	4832	5206	5580	5953	6326	6699	7071	7443	7815
7	8186	8557	8928	9298	9668	070038	070407	070776	071145	071514
8	071882	072250	072617	072985	073352	3718	4085	4451	4816	5181
9	5547	5912	6276	6640	7004	7368	7731	8094	8457	8820
120	079181	079543	079904	080266	080626	080987	081347	081707	082067	082427
1	082785	083144	083503	3861	4219	4576	4934	5291	5647	6004
2	6360	6716	7071	7426	7781	8136	8490	8845	9198	9551
3	9905	090258	090611	090963	091315	091667	092018	092370	092721	093073
4	093422	3772	4122	4471	4820	5169	5518	5866	6215	6563
5	6910	7257	7604	7951	8298	8644	8990	9335	9681	100000
6	100371	100715	101059	101403	101747	102091	102434	102777	103119	3
7	3804	4146	4487	4828	5169	5510	5851	6191	6531	6871
8	7210	7549	7888	8227	8565	8903	9241	9579	9916	102540
9	110590	110926	111263	111599	111934	112270	112605	112940	113275	3
130	113943	114277	114611	114944	115278	115611	115943	116276	116608	116940
1	7271	7603	7934	8265	8595	8926	9256	9586	9915	120000
2	120574	120903	121231	121560	121888	122216	122544	122871	123198	3
3	3852	4178	4504	4830	5156	5481	5806	6131	6456	6
4	7105	7429	7753	8076	8399	8722	9045	9368	9690	130000
5	130334	130655	130977	131298	131619	131939	132260	132580	132900	3
6	3539	3858	4177	4496	4814	5133	5451	5769	6086	6
7	6721	7037	7354	7671	7987	8303	8618	8934	9249	9
8	9879	140194	140508	140822	141136	141450	141763	142076	142389	142702
9	143015	3327	3639	3951	4263	4574	4885	5196	5507	5
140	146129	146438	146748	147058	147367	147676	147985	148294	148603	148912
1	9219	9527	9835	150142	150449	150756	151063	151370	151676	151983
2	152288	152594	152900	3205	3510	3815	4120	4424	4728	5
3	5336	5640	5943	6246	6549	6852	7154	7457	7759	8
4	8362	8664	8965	9266	9567	9868	160168	160469	160769	161069
5	161368	161667	161967	162266	162564	162863	3161	3460	3758	4
6	4353	4650	4947	5244	5541	5838	6134	6430	6726	7
7	7317	7613	7908	8203	8497	8792	9086	9380	9674	9
8	170262	170555	170848	171141	171434	171726	172019	172311	172603	172895
9	3186	3478	3769	4060	4351	4641	4932	5222	5512	5
150	176091	176381	176670	176959	177248	177536	177825	178113	178401	178689
1	8977	9264	9552	9839	180126	180413	180699	180986	181272	181558
2	181844	182129	182415	182700	2985	3270	3555	3839	4123	4
3	4691	4975	5259	5542	5825	6108	6391	6674	6956	7
4	7521	7803	8084	8366	8647	8928	9209	9490	9771	190000
5	190332	190612	190892	191171	191451	191730	192010	192289	192567	2
6	3125	3403	3681	3959	4237	4514	4792	5069	5346	5
7	5900	6176	6453	6729	7005	7281	7556	7832	8107	8
8	8657	8932	9206	9481	9755	200029	200303	200577	200850	201124
9	201397	201670	201943	202216	202488	2761	3033	3305	3577	3
N.	0	1	2	3	4	5	6	7	8	9

OF NUMBERS.

3

N.	0	1	2	3	4	5	6	7	8	9	D.
100	201120	204391	204663	204934	205204	205475	205746	206018	206288	206556	271
1	6826	7096	7365	7634	7904	8173	8441	8710	8979	9247	269
2	9515	9783	210051	210319	210586	210853	211121	211389	211654	211921	267
3	212188	212454	2720	2986	3252	3518	3783	4049	4314	4579	266
4	4844	5109	5373	5638	5902	6166	6430	6694	6957	7221	264
5	7484	7747	8010	8273	8536	8798	9060	9323	9585	9846	262
6	220103	220370	220631	220892	221153	221414	221675	221936	222196	222456	261
7	2716	2976	3236	3496	3755	4015	4274	4533	4792	5051	259
8	5309	5568	5826	6084	6342	6600	6858	7115	7372	7630	258
9	7887	8144	8400	8657	8913	9170	9426	9682	9938	230193	256
170	230449	230704	230960	231215	231470	231724	231979	232234	232488	232742	255
1	2996	3250	3504	3757	4011	4264	4517	4770	5023	5276	253
2	5528	5781	6033	6285	6537	6789	7041	7292	7544	7795	252
3	8046	8297	8548	8799	9049	9299	9550	9800	240050	240300	250
4	240549	240799	241048	241297	241546	241795	242044	242293	2541	2790	249
5	3033	3286	3534	3782	4030	4277	4525	4772	5019	5266	248
6	5513	5759	6006	6252	6499	6745	6991	7237	7482	7728	246
7	7973	8219	8464	8709	8954	9198	9443	9687	9932	250176	245
8	250420	250664	250908	251151	251395	251638	251881	252125	252368	2610	243
9	2853	3096	3338	3580	3822	4064	4306	4548	4790	5031	242
180	255273	255514	255755	255996	256237	256477	256718	256958	257198	257439	241
1	7679	7918	8158	8398	8637	8877	9116	9355	9594	9833	239
2	260071	260310	260548	260787	261025	261263	261501	261739	261976	262214	238
3	2451	2688	2925	3162	3399	3636	3873	4109	4346	4582	237
4	4818	5054	5290	5525	5761	5996	6232	6467	6702	6937	235
5	7172	7406	7641	7875	8110	8344	8578	8812	9046	9279	234
6	9513	9746	9980	270213	270446	270679	270912	271144	271377	271609	233
7	271842	272074	272306	2538	2770	3001	3233	3464	3696	3927	232
8	4158	4389	4620	4850	5081	5311	5542	5772	6002	6232	230
9	6462	6692	6921	7151	7380	7609	7838	8067	8296	8525	229
190	278754	278982	279211	279439	279667	279895	280123	280351	280578	280806	228
1	281033	281261	281488	281715	281942	282169	282396	282622	282849	3075	227
2	3301	3527	3753	3979	4205	4431	4656	4882	5107	5332	226
3	5557	5782	6007	6232	6456	6681	6905	7130	7354	7578	225
4	7802	8026	8249	8473	8696	8920	9143	9366	9589	9812	223
5	290035	290257	290480	290702	290925	291147	291369	291591	291813	292034	222
6	2256	2478	2699	2920	3141	3363	3584	3804	4025	4246	221
7	4466	4687	4907	5127	5347	5567	5787	6007	6226	6446	220
8	6665	6884	7104	7323	7542	7761	7979	8198	8416	8635	219
9	8853	9071	9289	9507	9725	9943	300161	300378	300595	300813	218
200	301030	301247	301464	301681	301898	302114	302331	302547	302764	302980	217
1	3196	3412	3628	3844	4059	4275	4491	4706	4921	5136	216
2	5351	5566	5781	5996	6211	6425	6639	6854	7068	7282	215
3	7496	7710	7924	8137	8351	8564	8778	8991	9204	9417	213
4	9630	9843	310056	310268	310481	310693	310906	311118	311330	311542	212
5	311754	311966	2177	2389	2600	2812	3023	3234	3445	3656	211
6	3867	4078	4289	4499	4710	4920	5130	5340	5551	5760	210
7	5970	6180	6390	6599	6809	7018	7227	7436	7646	7854	209
8	8063	8272	8481	8689	8898	9106	9314	9522	9730	9938	208
9	320146	320354	320562	320769	320977	321184	321391	321598	321805	322012	207
210	322219	322426	322633	322839	323046	323252	323458	323665	323871	324077	206
1	4282	4488	4694	4899	5105	5310	5516	5721	5926	6131	205
2	6336	6541	6745	6950	7155	7359	7563	7767	7972	8176	204
3	9380	9583	9787	9991	9194	9398	9601	9805	330008	330211	203
4	330414	330617	330819	331022	331225	331427	331630	331832	2034	2236	202
5	2438	2640	2842	3044	3246	3447	3649	3850	4051	4253	202
6	4454	4655	4856	5057	5257	5458	5658	5859	6059	6260	201
7	6460	6660	6860	7060	7260	7459	7659	7858	8058	8257	200
8	8456	8656	8855	9054	9253	9451	9650	9849	340017	340216	199
9	340444	340642	340841	341039	341237	341435	341632	341830	2020	2225	198
N.	0	1	2	3	4	5	6	7	8	9	D.

N.	0	1	2	3	4	5	6	7	8	9
220	342423	342620	342817	343014	343212	343409	343606	343802	343999	344196
1	4392	4589	4785	4981	5178	5374	5570	5766	5962	6158
2	6353	6549	6744	6939	7135	7330	7525	7720	7915	8111
3	8305	8500	8694	8889	9083	9278	9472	9666	9860	35005
4	350248	350442	350636	350829	351023	351216	351410	351603	351796	190
5	2183	2375	2568	2761	2954	3147	3339	3532	3724	391
6	4108	4301	4493	4685	4876	5068	5260	5452	5643	583
7	6026	6217	6408	6599	6790	6981	7172	7363	7554	774
8	7935	8125	8316	8506	8696	8886	9076	9266	9456	964
9	9835	360025	360215	360404	360593	360783	360972	361161	361350	361539
230	361728	361917	362105	362294	362482	362671	362859	363048	363236	363424
1	3612	3800	3988	4176	4363	4551	4739	4926	5113	530
2	5488	5675	5862	6049	6236	6423	6610	6796	6983	716
3	7356	7542	7729	7915	8101	8287	8473	8659	8845	903
4	9216	9401	9587	9772	9958	370143	370328	370513	370698	37088
5	371068	371253	371437	371622	371806	1991	2175	2360	2544	272
6	2912	3096	3280	3464	3647	3831	4015	4198	4382	456
7	4748	4932	5115	5298	5481	5664	5846	6029	6212	639
8	6577	6759	6942	7124	7306	7488	7670	7852	8034	821
9	8398	8580	8761	8943	9124	9306	9487	9668	9849	38003
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5	6694	6785	6876	6968	7059	7151	7242	7333	7424	7516	91
6	7607	7698	7789	7881	7972	8063	8154	8245	8336	8427	91
7	8518	8609	8700	8791	8882	8973	9064	9155	9246	9337	91
8	9428	9519	9610	9700	9791	9882	9973	680063	680154	680245	91
9	680336	680426	680517	680607	680698	680789	680879	0970	1060	1151	91
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2	3047	3137	3227	3317	3407	3497	3587	3677	3767	3857	90
3	3947	4037	4127	4217	4307	4396	4486	4576	4666	4756	90
4	4845	4935	5025	5114	5204	5294	5383	5473	5563	5652	90
5	5742	5831	5921	6010	6100	6189	6279	6368	6458	6547	89
6	6636	6726	6815	6904	6994	7083	7172	7261	7351	7440	89
7	7529	7618	7707	7796	7886	7975	8064	8153	8242	8331	89
8	8420	8509	8598	8687	8776	8865	8953	9042	9131	9220	89
9	9309	9398	9486	9575	9664	9753	9841	9930	690019	690107	89
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1	1081	1170	1258	1347	1435	1524	1612	1700	1789	1877	88
2	1965	2053	2142	2230	2318	2406	2494	2583	2671	2759	88
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4	3727	3815	3903	3991	4078	4166	4254	4342	4430	4517	88
5	4605	4693	4781	4868	4956	5044	5131	5219	5307	5394	88
6	5482	5569	5657	5744	5832	5919	6007	6094	6182	6269	87
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8	7229	7317	7404	7491	7578	7665	7752	7839	7926	8014	87
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3	1568	1654	1741	1827	1913	1999	2086	2172	2258	2344	86
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4	0963	1048	1132	1217	1301	1385	1470	1554	1639	1723	84
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8	4330	4414	4497	4581	4665	4749	4833	4916	5000	5084	84
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4	9331	9414	9497	9580	9663	9745	9828	9911	9994	720077	83
5	720159	720242	720325	720407	720490	720573	720655	720738	720821	0903	83
6	0996	1068	1151	1233	1316	1398	1481	1563	1646	1728	82
7	1811	1893	1975	2058	2140	2222	2305	2387	2469	2552	82
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9	3456	3538	3620	3702	3784	3866	3948	4030	4112	4194	82
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6	9165	9246	9327	9408	9489	9570	9651	9732	9813	9893	81
7	9974	730055	730136	730217	730298	730378	730459	730540	730621	730702	81
8	730782	0963	0944	1024	1105	1186	1266	1347	1428	1508	81
9	1589	1669	1750	1830	1911	1991	2072	2152	2233	2313	81
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8	8781	8860	8939	9018	9097	9177	9256	9335	9414	9493	79
9	9572	9651	9731	9810	9889	9968	740047	740126	740205	740284	79
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2	1939	2018	2096	2175	2254	2332	2411	2489	2568	2647	79
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6	5075	5153	5231	5309	5387	5465	5543	5621	5699	5777	78
7	5855	5933	6011	6089	6167	6245	6323	6401	6479	6556	78
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2	9736	9814	9891	9968	750045	750123	750200	750277	750354	750431	77
3	750508	750586	750663	750740	0817	0894	0971	1048	1125	1202	77
4	1279	1356	1433	1510	1587	1664	1741	1818	1895	1972	77
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7	3583	3660	3736	3813	3889	3966	4042	4119	4195	4272	77
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9	5112	5189	5265	5341	5417	5494	5570	5646	5722	5799	76
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2	4923	4998	5072	5147	5221	5296	5370	5445	5520
3	5669	5743	5818	5892	5966	6041	6115	6190	6264
4	6413	6487	6562	6636	6710	6785	6859	6933	7007
5	7156	7230	7304	7379	7453	7527	7601	7675	7749
6	7898	7972	8046	8120	8194	8268	8342	8416	8490
7	8638	8712	8786	8860	8934	9008	9082	9156	9230
8	9377	9451	9525	9599	9673	9746	9820	9894	9968
9	770115	770189	770263	770336	770410	770484	770557	770631	770705
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5	4517	4590	4663	4736	4809	4882	4955	5028	5100
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7	5974	6047	6120	6193	6265	6338	6411	6483	6556
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9	7427	7499	7572	7644	7717	7789	7862	7934	8006
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2	9596	9669	9741	9813	9885	9957	780029	780101	780173
3	780317	780389	780461	780533	780605	780677	0749	0821	0893
4	1037	1109	1181	1253	1324	1396	1468	1540	1612
5	1755	1827	1899	1971	2042	2114	2186	2258	2329
6	2473	2544	2616	2688	2759	2831	2902	2974	3046
7	3189	3260	3332	3403	3475	3546	3618	3689	3761
8	3904	3975	4046	4118	4189	4261	4332	4403	4475
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5	8875	8946	9016	9087	9157	9228	9299	9369	9440
6	9581	9651	9722	9792	9863	9933	790004	790074	790144
7	790285	790356	790426	790496	790567	790637	0707	0778	0848
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9	1691	1761	1831	1901	1971	2041	2111	2181	2252
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5	5880	5949	6019	6088	6158	6227	6297	6366	6436
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6	3457	3525	3594	3662	3730	3798	3867	3935	4003
7	4139	4206	4276	4344	4412	4480	4548	4616	4685
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6	810233	810300	810367	810434	810501	810569	810636	0703	0770	0837	67
7	0904	0971	1039	1106	1173	1240	1307	1374	1441	1508	67
8	1575	1642	1709	1776	1843	1910	1977	2044	2111	2178	67
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4	5578	5644	5711	5777	5843	5910	5976	6042	6109	6175	66
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9	8885	8951	9017	9083	9149	9215	9281	9346	9412	9478	66
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3	1514	1579	1645	1710	1775	1841	1906	1972	2037	2103	65
4	2168	2233	2299	2364	2430	2495	2560	2626	2691	2756	65
5	2822	2887	2952	3018	3083	3148	3213	3279	3344	3409	65
6	3474	3539	3605	3670	3735	3800	3865	3930	3996	4061	65
7	4126	4191	4256	4321	4386	4451	4516	4581	4646	4711	65
8	4776	4841	4906	4971	5036	5101	5166	5231	5296	5361	65
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5	9304	9368	9432	9497	9561	9625	9690	9754	9818	9882	64
6	9947	830011	830075	830139	830204	830268	830332	830396	830460	830525	64
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4	5056	5120	5183	5247	5310	5373	5437	5500	5564	5627	63
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6	6324	6387	6451	6514	6577	6641	6704	6767	6830	6894	63
7	6957	7020	7083	7146	7210	7273	7336	7399	7462	7525	63
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9	8219	8282	8345	8408	8471	8534	8597	8660	8723	8786	63
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3	0733	0796	0859	0921	0984	1046	1109	1172	1234	1297	63
4	1359	1422	1485	1547	1610	1672	1735	1797	1860	1922	63
5	1985	2047	2110	2172	2235	2297	2360	2422	2484	2547	62
6	2609	2672	2734	2796	2859	2921	2983	3046	3108	3170	62
7	3233	3295	3357	3420	3482	3544	3606	3669	3731	3793	62
8	3855	3918	3980	4042	4104	4166	4229	4291	4353	4415	62
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3	6955	7017	7079	7141	7202	7264	7326	7388	7449	7511	62
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5	8189	8251	8312	8374	8435	8497	8559	8620	8682	8743	62
6	8805	8866	8928	8989	9051	9112	9174	9235	9297	9358	61
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8	850033	850095	850156	850217	850279	850340	850401	850462	850524	850585	61
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6	4913	4974	5034	5095	5156	5216	5277	5337	5398	5459	61
7	5519	5580	5640	5701	5761	5822	5882	5943	6003	6064	61
8	6124	6185	6245	6306	6366	6427	6487	6548	6608	6668	60
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7	1534	1594	1654	1714	1773	1833	1893	1952	2012	2072	60
8	2131	2191	2251	2310	2370	2430	2489	2549	2608	2668	60
9	2728	2787	2847	2906	2966	3025	3085	3144	3204	3263	60
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4	5696	5755	5814	5874	5933	5992	6051	6110	6169	6228	59
5	6287	6346	6405	6465	6524	6583	6642	6701	6760	6819	59
6	6878	6937	6996	7055	7114	7173	7232	7291	7350	7409	59
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4	1573	1631	1690	1748	1806	1865	1923	1981	2040	2098	59
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6	2739	2797	2855	2913	2972	3030	3088	3146	3204	3262	59
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9	4482	4540	4598	4656	4714	4772	4830	4888	4945	5003	59
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2	6218	6276	6333	6391	6449	6507	6564	6622	6680	6737	58
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4	7371	7429	7487	7544	7602	7659	7717	7774	7832	7889	58
5	7947	8004	8062	8119	8177	8234	8292	8349	8407	8464	57
6	8522	8579	8637	8694	8752	8809	8866	8924	8981	9039	57
7	9096	9153	9211	9268	9325	9383	9440	9497	9555	9612	57
8	9669	9726	9784	9841	9898	9956	880013	880070	880127	880185	57
9	880242	880299	880356	880413	880471	880528	0585	0642	0699	0757	57
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2	1955	2012	2069	2126	2183	2240	2297	2354	2411	2468	57
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5	3661	3718	3775	3832	3888	3945	4002	4059	4115	4172	57
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8	5361	5418	5474	5531	5587	5644	5700	5757	5813	5870	57
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5	9302	9358	9414	9470	9526	9582	9638	9694	9750	9806	56
6	9862	9918	9974	890030	890086	890141	890197	890253	890309	890365	56
7	890421	890477	890533	0589	0645	0700	0756	0812	0868	0924	56
8	0980	1035	1091	1147	1203	1259	1314	1370	1426	1482	56
9	1537	1593	1649	1705	1760	1816	1872	1928	1983	2039	56
0	892095	892150	892206	892262	892317	892373	892429	892484	892540	892595	56
1	2651	2707	2762	2818	2873	2929	2985	3040	3096	3151	56
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3	3762	3817	3873	3928	3984	4039	4094	4150	4205	4261	55
4	4316	4371	4427	4482	4538	4593	4648	4704	4759	4814	55
5	4870	4925	4980	5036	5091	5146	5201	5257	5312	5367	55
6	5423	5478	5533	5588	5644	5699	5754	5809	5864	5920	55
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9	7077	7132	7187	7242	7297	7352	7407	7462	7517	7572	55
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6	0913	0968	1022	1077	1131	1186	1240	1295	1349	1404	55
7	1458	1513	1567	1622	1676	1731	1785	1840	1894	1948	54
8	2003	2057	2112	2166	2221	2275	2329	2384	2438	2492	54
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3	4716	4770	4824	4878	4932	4986	5040	5094	5148	5202	54
4	5256	5310	5364	5418	5472	5526	5580	5634	5688	5742	54
5	5796	5850	5904	5958	6012	6066	6119	6173	6227	6281	54
6	6335	6389	6443	6497	6551	6604	6658	6712	6766	6820	54
7	6874	6927	6981	7035	7089	7143	7196	7250	7304	7358	54
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2	9556	9610	9663	9716	9770	9823	9877	9930	9984	910037	53
3	910091	910144	910197	910251	910304	910358	910411	910464	910518	0571	53
4	0624	0678	0731	0784	0838	0891	0944	0998	1051	1104	53
5	1158	1211	1264	1317	1371	1424	1477	1530	1584	1637	53
6	1690	1743	1797	1850	1903	1956	2009	2063	2116	2169	53
7	2222	2275	2328	2381	2435	2488	2541	2594	2647	2700	53
8	2753	2806	2859	2913	2966	3019	3072	3125	3178	3231	53
9	3284	3337	3390	3443	3496	3549	3602	3655	3708	3761	53
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1	4343	4396	4449	4502	4555	4608	4660	4713	4766	4819
2	4872	4925	4977	5030	5083	5136	5189	5241	5294	5347
3	5400	5453	5505	5558	5611	5664	5716	5769	5822	5875
4	5927	5980	6033	6085	6138	6191	6243	6296	6349	6402
5	6454	6507	6559	6612	6664	6717	6770	6822	6875	6928
6	6980	7033	7085	7138	7190	7243	7295	7348	7400	7453
7	7506	7558	7611	7663	7716	7768	7820	7873	7925	7978
8	8030	8083	8135	8188	8240	8293	8345	8397	8450	8503
9	8555	8607	8659	8712	8764	8816	8869	8921	8973	9026
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4	1166	1218	1270	1322	1374	1426	1478	1530	1582	1634
5	1686	1738	1790	1842	1894	1946	1998	2050	2102	2154
6	2206	2258	2310	2362	2414	2466	2518	2570	2622	2674
7	2725	2777	2829	2881	2933	2985	3037	3089	3141	3193
8	3244	3296	3348	3399	3451	3503	3555	3607	3658	3710
9	3762	3814	3865	3917	3969	4021	4072	4124	4176	4228
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2	5312	5364	5415	5467	5518	5570	5621	5673	5725	5776
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4	6342	6394	6445	6497	6548	6600	6651	6702	6754	6805
5	6857	6908	6959	7011	7062	7114	7165	7216	7268	7319
6	7370	7422	7473	7524	7576	7627	7678	7730	7781	7832
7	7883	7935	7986	8037	8088	8140	8191	8242	8293	8344
8	8396	8447	8498	8549	8601	8652	8703	8754	8805	8856
9	8908	8959	9010	9061	9112	9163	9215	9266	9317	9368
850	929419	929470	929521	929572	929623	929674	929725	929776	929827	929878
1	9930	9981	930032	930083	930134	930185	930236	930287	930338	930389
2	930440	930491	0542	0592	0643	0694	0745	0796	0847	0898
3	0949	1000	1051	1102	1153	1204	1254	1305	1356	1407
4	1458	1509	1560	1610	1661	1712	1763	1814	1865	1916
5	1966	2017	2068	2118	2169	2220	2271	2322	2372	2423
6	2474	2524	2575	2626	2677	2727	2778	2829	2879	2930
7	2981	3031	3082	3133	3183	3234	3285	3335	3386	3437
8	3487	3538	3589	3639	3690	3740	3791	3841	3892	3943
9	3993	4044	4094	4145	4195	4246	4296	4347	4397	4448
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7	8019	8069	8119	8169	8219	8269	8320	8370	8420	8471
8	8520	8570	8620	8670	8720	8770	8820	8870	8920	8971
9	9020	9070	9120	9170	9220	9270	9320	9369	9419	9470
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3	1014	1064	1114	1163	1213	1263	1313	1362	1412	1462
4	1511	1561	1611	1660	1710	1760	1809	1859	1909	1959
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6	2504	2554	2603	2653	2702	2752	2801	2851	2901	2951
7	3000	3049	3099	3148	3198	3247	3297	3346	3396	3445
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4	5961	6010	6059	6108	6157	6207	6256	6305	6354	6403	49
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7	7434	7483	7532	7581	7630	7679	7728	7777	7826	7875	49
8	7924	7973	8022	8070	8119	8168	8217	8266	8315	8364	49
9	8413	8462	8511	8560	8609	8657	8706	8755	8804	8853	49
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11	9390	949439	949488	949536	949585	949634	949683	949731	949780	949829	49
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13	950365	950414	950462	0511	0560	0608	0657	0706	0754	0803	49
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15	1338	1386	1435	1483	1532	1580	1629	1677	1726	1775	49
16	1823	1872	1920	1969	2017	2066	2114	2163	2211	2260	48
17	2308	2356	2405	2453	2502	2550	2599	2647	2696	2744	48
18	2792	2841	2889	2938	2986	3034	3083	3131	3180	3228	48
19	3276	3325	3373	3421	3470	3518	3566	3615	3663	3711	48
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21	954243	954291	954339	954387	954435	954484	954532	954580	954628	954677	48
22	4725	4773	4821	4869	4918	4966	5014	5062	5110	5158	48
23	5207	5255	5303	5351	5399	5447	5495	5543	5592	5640	48
24	5688	5736	5784	5832	5880	5928	5976	6024	6072	6120	48
25	6168	6216	6265	6313	6361	6409	6457	6505	6553	6601	48
26	6649	6697	6745	6793	6840	6888	6936	6984	7032	7080	48
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29	8086	8134	8181	8229	8277	8325	8373	8421	8468	8516	48
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31	959041	959089	959137	959185	959232	959280	959328	959375	959423	959471	48
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35	4	0946	0994	1041	1089	1136	1184	1231	1279	1326	48
36	5	1421	1469	1516	1563	1611	1658	1706	1753	1801	48
37	6	1895	1943	1990	2038	2085	2132	2180	2227	2275	47
38	7	2369	2417	2464	2511	2559	2606	2653	2701	2748	47
39	8	2843	2890	2937	2985	3032	3079	3126	3174	3221	47
40	9	3316	3363	3410	3457	3504	3552	3599	3646	3693	47
41	963788	963835	963882	963929	963977	964024	964071	964118	964165	964212	47
42	1	4260	4307	4354	4401	4448	4495	4542	4590	4637	47
43	2	4731	4778	4825	4872	4919	4966	5013	5061	5108	47
44	3	5202	5249	5296	5343	5390	5437	5484	5531	5578	47
45	4	5672	5719	5766	5813	5860	5907	5954	6001	6048	47
46	5	6142	6189	6236	6283	6329	6376	6423	6470	6517	47
47	6	6611	6658	6705	6752	6799	6845	6892	6939	6986	47
48	7	7080	7127	7173	7220	7267	7314	7361	7408	7454	47
49	8	7548	7595	7642	7688	7735	7782	7829	7875	7922	47
50	9	8016	8062	8109	8156	8203	8249	8296	8343	8390	47
51	968483	968530	968576	968623	968670	968716	968763	968810	968856	968903	47
52	1	8950	8996	9043	9090	9136	9183	9229	9276	9323	47
53	2	9416	9463	9503	9556	9602	9649	9695	9742	9789	47
54	3	9882	9926	9975	970021	970068	970114	970161	970207	970254	47
55	4	970347	970393	970440	0486	0533	0579	0626	0672	0719	46
56	5	0812	0858	0904	0951	0997	1044	1090	1137	1183	46
57	6	1276	1322	1369	1415	1461	1508	1554	1601	1647	46
58	7	1740	1786	1832	1879	1925	1971	2018	2064	2110	46
59	8	2203	2249	2295	2342	2388	2434	2481	2527	2573	46
60	9	2666	2712	2758	2804	2851	2897	2943	2989	3035	46
61	0	1	2	3	4	5	6	7	8	9	D.

N.	0	1	2	3	4	5	6	7	8	9	D.
940	973128	973174	973220	973266	973313	973359	973405	973451	973497	973543	46
1	3590	3636	3682	3728	3774	3820	3866	3913	3959	4005	46
2	4051	4097	4143	4189	4235	4281	4327	4374	4420	4466	46
3	4512	4558	4604	4650	4696	4742	4788	4834	4880	4926	46
4	4972	5018	5064	5110	5156	5202	5248	5294	5340	5386	46
5	5432	5478	5524	5570	5616	5662	5707	5753	5799	5845	46
6	5891	5937	5983	6029	6075	6121	6167	6212	6258	6304	46
7	6350	6396	6442	6488	6533	6579	6625	6671	6717	6763	46
8	6808	6854	6900	6946	6992	7037	7083	7129	7175	7220	46
9	7266	7312	7358	7403	7449	7495	7541	7586	7632	7678	46
950	977724	977769	977815	977861	977906	977952	977998	978043	978089	978135	46
1	8181	8226	8272	8317	8363	8409	8454	8500	8546	8591	46
2	8637	8683	8728	8774	8819	8865	8911	8956	9002	9047	46
3	9093	9138	9184	9230	9275	9321	9366	9412	9457	9503	46
4	9548	9594	9639	9685	9730	9776	9821	9867	9912	9958	46
5	980003	980049	980094	980140	980185	980231	980276	980322	980367	980412	45
6	0458	0503	0549	0594	0640	0685	0730	0776	0821	0867	45
7	0912	0957	1003	1048	1093	1139	1184	1229	1275	1320	45
8	1366	1411	1456	1501	1547	1592	1637	1683	1728	1773	45
9	1819	1864	1909	1954	2000	2045	2090	2135	2181	2226	45
960	992271	992316	992362	992407	992452	992497	992543	992588	992633	992678	45
1	2723	2769	2814	2859	2904	2949	2994	3040	3085	3130	45
2	3175	3220	3265	3310	3356	3401	3446	3491	3536	3581	45
3	3626	3671	3716	3762	3807	3852	3897	3942	3987	4032	45
4	4077	4122	4167	4212	4257	4302	4347	4392	4437	4482	45
5	4527	4572	4617	4662	4707	4752	4797	4842	4887	4932	45
6	4977	5022	5067	5112	5157	5202	5247	5292	5337	5382	45
7	5426	5471	5516	5561	5606	5651	5696	5741	5786	5830	45
8	5875	5920	5965	6010	6055	6100	6144	6189	6234	6279	45
9	6324	6369	6413	6458	6503	6548	6593	6637	6682	6727	45
970	986772	986817	986861	986906	986951	986996	987040	987085	987130	987175	45
1	7219	7264	7309	7353	7398	7443	7488	7532	7577	7622	45
2	7666	7711	7756	7800	7845	7890	7934	7979	8024	8068	45
3	8113	8157	8202	8247	8291	8336	8381	8425	8470	8514	45
4	8559	8604	8648	8693	8737	8782	8826	8871	8916	8960	45
5	9005	9049	9094	9138	9183	9227	9272	9316	9361	9405	45
6	9450	9494	9539	9583	9628	9672	9717	9761	9806	9850	44
7	9895	9939	9983	990028	990072	990117	990161	990206	990250	990294	44
8	990339	990383	990428	0472	0516	0561	0605	0650	0694	0738	44
9	0783	0827	0871	0916	0960	1004	1049	1093	1137	1182	44
980	991226	991270	991315	991359	991403	991448	991492	991536	991580	991625	44
1	1669	1713	1758	1802	1846	1890	1935	1979	2023	2067	44
2	2111	2156	2200	2244	2288	2333	2377	2421	2465	2509	44
3	2554	2598	2642	2686	2730	2774	2819	2863	2907	2951	44
4	2995	3039	3083	3127	3172	3216	3260	3304	3348	3392	44
5	3436	3480	3524	3568	3613	3657	3701	3745	3789	3833	44
6	3877	3921	3965	4009	4053	4097	4141	4185	4229	4273	44
7	4317	4361	4405	4449	4493	4537	4581	4625	4669	4713	44
8	4757	4801	4845	4889	4933	4977	5021	5065	5109	5153	44
9	5196	5240	5284	5328	5372	5416	5460	5504	5547	5591	44
990	995635	995679	995723	995767	995811	995854	995898	995942	995986	996030	44
1	6074	6117	6161	6205	6249	6293	6337	6380	6424	6468	44
2	6512	6555	6599	6643	6687	6731	6774	6818	6862	6906	44
3	6949	6993	7037	7080	7124	7168	7212	7255	7299	7343	44
4	7386	7430	7474	7517	7561	7605	7648	7692	7736	7779	44
5	7823	7867	7910	7954	7998	8041	8085	8129	8172	8216	44
6	8259	8303	8347	8390	8434	8477	8521	8564	8608	8652	44
7	8695	8739	8782	8826	8869	8913	8956	9000	9043	9087	44
8	9131	9174	9218	9261	9305	9348	9392	9435	9479	9522	44
9	9565	9609	9652	9696	9739	9783	9826	9870	9913	9957	43
N.	0	1	2	3	4	5	6	7	8	9	D.

TABLE FOR REDUCING COMMON TO HYPERBOLIC LOGARITHMS.

Com. Log.	Hyperb. Log.	Com. Log.	Hyperb. Log.	Com. Log.	Hyperb. Log.	Com. Log.	Hyperb. Log.	Com. Log.	Hyperb. Log.
01	02302585	21	48354287	41	94405989	61	140457091	81	186509393
02	04605170	22	50656572	42	96708574	62	142760276	82	188811978
03	06907755	23	52959457	43	99011159	63	145062861	83	191114563
04	09210340	24	55262042	44	101313744	64	147365446	84	193417148
05	11512925	25	57564627	45	103616329	65	149668031	85	195719733
06	13815511	26	59867212	46	105918914	66	151970616	86	198022318
07	16118096	27	62169798	47	108221499	67	154273201	87	200324903
08	18420681	28	64472383	48	110524084	68	156575786	88	202627488
09	20723266	29	66774968	49	112826670	69	158878371	89	204930073
10	23025851	30	69077553	50	115129255	70	161180956	90	207232658
11	25328436	31	71380138	51	117431840	71	163483541	91	209535243
12	27631021	32	73682723	52	119734425	72	165786126	92	211837828
13	29933606	33	75985308	53	122037010	73	168088711	93	214140413
14	32236191	34	78287893	54	124339595	74	170391296	94	216442998
15	34538776	35	80590478	55	126642180	75	172693881	95	218745583
16	36841361	36	82893063	56	128944765	76	174996466	96	221048168
17	39143946	37	85195648	57	131247350	77	177299051	97	223350753
18	41446532	38	87498233	58	133549935	78	179601636	98	225653338
19	43749117	39	89800818	59	135852520	79	181904221	99	227955923
20	46051702	40	92103404	60	138155106	80	184206806	100	230258508

TABLE OF THE GEOGRAPHICAL MILES
IN A DEGREE OF LONGITUDE AT EVERY
DEGREE OF LATITUDE ON THE TER-
RESTRIAL SPHEROID, THE ELLIPTI-
CITY BEING ASSUMED $\frac{1}{300}$.

Lat.	1° Long.	Lat.	1° Long.	Lat.	1° Long.
Miles.	Miles.	Miles.	Miles.	Miles.	Miles.
0	60.000	30	52.004	60	30.074
1	59.991	31	51.475	61	29.162
2	59.963	32	50.929	62	28.241
3	59.918	33	50.369	63	27.311
4	59.855	34	49.793	64	26.373
5	59.773	35	49.202	65	25.426
6	59.673	36	48.596	66	24.472
7	59.556	37	47.975	67	23.510
8	59.421	38	47.339	68	22.541
9	59.267	39	46.689	69	21.565
10	59.095	40	46.025	70	20.581
11	58.905	41	45.346	71	19.592
12	58.698	42	44.654	72	18.596
13	58.472	43	43.948	73	17.595
14	58.229	44	43.228	74	16.589
15	57.969	45	42.496	75	15.576
16	57.690	46	41.750	76	14.560
17	57.395	47	40.991	77	13.539
18	57.081	48	40.220	78	12.514
19	56.751	49	39.437	79	11.485
20	56.403	50	38.641	80	10.452
21	56.038	51	37.834	81	9.416
22	55.656	52	37.014	82	8.378
23	55.258	53	36.184	83	7.337
24	54.842	54	35.342	84	6.293
25	54.411	55	34.491	85	5.247
26	53.962	56	33.628	86	4.199
27	53.497	57	32.754	87	3.149
28	53.015	58	31.870	88	2.100
29	52.518	59	30.977	89	1.050
30	52.004	60	30.074	90	0.000

TABLE OF THE VELOCITY AND THE
FORCE OF THE WIND.

Miles per Hr.	VELOCITY.		Force on 1 Square Foot in Pounds Avoir.	Character of the Wind.
	Pt.	per Second.		
1	1.47	.005		{ Hardly per- ceptible. Just percep- tible.
2	2.93	.020		
3	4.40	.044		
4	5.87	.079		Gentle, plea- sant wind.
5	7.33	.123		
6	8.80	.177		
7	10.27	.241		Moderate breeze.
8	11.73	.315		
9	13.20	.399		
10	14.67	.492		Pleasant, brisk gale.
11	16.13	.595		
12	17.60	.708		
13	19.07	.831		
14	20.53	.964		
15	22.00	1.107		Very brisk.
20	29.33	1.968		
25	36.67	3.075		
30	44.00	4.429		High winds.
35	51.33	6.027		
40	58.67	7.873		Very high.
45	66.00	9.963		
50	73.33	12.300		
55	80.67	14.883		Storm or tempest.
60	88.00	17.715		
65	95.33	20.787		Great storm.
70	102.67	24.108		
75	110.00	27.675		Hurricane.
80	117.33	31.490		
85	124.67	35.547		Destructive hurricane.
90	132.00	39.852		
100	146.67	49.200		

A TABLE OF THE ANGLES WHICH EVERY POINT AND QUARTER POINT OF THE COMPASS MAKES WITH THE MERIDIAN.

North.		Points.	° ' "	Points.	South.	
		0	2 48 45	0		
		0	5 37 30	0		
		0	8 26 15	0		
N. b. E.	N. b. W.	1	11 15 0	1	S. b. E.	S. b. W.
		1	14 3 45	1		
		1	16 52 30	1		
		1	19 41 15	1		
N. N. E.	N. N. W.	2	22 30 0	2	S. S. E.	S. S. W.
		2	25 18 45	2		
		2	28 7 30	2		
		2	30 56 15	2		
N. E. b. N.	N. W. b. N.	3	33 45 0	3	S. E. b. S.	S. W. b. S.
		3	36 33 45	3		
		3	39 22 30	3		
		3	42 11 15	3		
N. E.	N. W.	4	45 0 0	4	S. E.	S. W.
		4	47 48 45	4		
		4	50 37 30	4		
		4	53 26 15	4		
N. E. b. E.	N. W. b. W.	5	56 15 0	5	S. E. b. E.	S. W. b. W.
		5	59 3 45	5		
		5	61 52 30	5		
		5	64 41 15	5		
E. N. E.	W. N. W.	6	67 30 0	6	E. S. E.	W. S. W.
		6	70 18 45	6		
		6	73 7 30	6		
		6	75 56 15	6		
E. b. N.	W. b. N.	7	78 45 0	7	E. b. S.	W. b. S.
		7	81 33 45	7		
		7	84 22 30	7		
		7	87 11 15	7		
East.	West.	8	90 0 0	8	East.	West.

A TABLE OF LOGARITHMIC SINES, TANGENTS, AND SECANTS EVERY POINT AND QUARTER POINT OF THE COMPASS.

Points.	Sine.	Cosine.	Tang.	Cotang.	Secant.	Cosec.	Points.
0	0.000000	10.000000	0.000000	Infinite.	10.000000	Infinite.	8
0	8.690796	9.999477	8.691319	11.308681	10.000523	11.309204	7
0	8.991302	9.997904	8.993398	11.006602	10.002096	11.008698	7
0	9.166520	9.995274	9.171247	10.828753	10.004726	10.833480	7
1	9.290236	9.991574	9.298662	10.701338	10.008426	10.709764	7
1	9.385571	9.986786	9.398785	10.601215	10.013214	10.614429	6
1	9.462824	9.980885	9.481939	10.518061	10.019115	10.537176	6
1	9.527488	9.973841	9.553647	10.446353	10.026159	10.472512	6
2	9.582840	9.965615	9.617224	10.382776	10.034385	10.417160	6
2	9.630992	9.956163	9.674829	10.325171	10.043837	10.369008	5
2	9.673387	9.945430	9.727957	10.272043	10.054570	10.326613	5
2	9.711050	9.933350	9.777700	10.222300	10.066650	10.288950	5
3	9.744739	9.919846	9.824893	10.175107	10.080154	10.255261	5
3	9.775027	9.904828	9.870199	10.129801	10.095172	10.224973	4
3	9.802359	9.888185	9.914173	10.085827	10.111815	10.197641	4
3	9.827084	9.869790	9.957295	10.042705	10.130210	10.172916	4
4	9.849485	9.849485	10.000000	10.000000	10.150515	10.150515	4
	Cosine.	Sine.	Cotang.	Tang.	Cosec.	Secant.	

0 Degree.				1 Degree.			
Sine.	Cosine.	Tang.	Cotang.	Sine.	Cosine.	Tang.	Cotang.
0.00000	10.00000	0.00000	Infinite.	8.241855	9.999934	8.241921	11.758079
463728	000000	6.463726	13.536274	249033	999932	249102	750898
764756	000000	764756	235244	256094	999929	256165	743835
940847	000000	940847	059153	263042	999927	263115	736885
065786	000000	7.065786	12.934214	269881	999925	269956	730044
162696	000000	162696	837304	276614	999922	276691	723309
241877	9.999999	241878	758122	283243	999920	283323	716677
308824	999999	308825	691175	289773	999918	289856	710144
368816	999999	368817	633183	296207	999915	296292	703708
417968	999999	417970	582030	302546	999913	302634	697366
463725	999998	463727	536273	308794	999910	308884	691116
7.505118	9.999998	7.505120	12.494880	8.314954	9.999907	8.315046	11.684954
542906	999997	542909	457091	321027	999905	321122	678878
577668	999997	577672	423238	327016	999902	327114	672886
609853	999996	609857	390143	332924	999899	333025	666975
639816	999996	639820	360180	338753	999897	338856	661144
667845	999995	667849	332151	344504	999894	344610	655390
694173	999995	694179	305821	350181	999891	350289	649711
718997	999994	719003	280997	355783	999888	355895	644105
742477	999993	742484	257516	361315	999885	361430	638570
764754	999993	764761	235239	366777	999882	366895	633105
7.785943	9.999992	7.785951	12.214049	8.372171	9.999879	8.372292	11.627708
806146	999991	806155	193845	377499	999876	377622	622378
825451	999990	825460	174540	382762	999873	382889	617111
843934	999989	843944	156056	387962	999870	388092	611908
861662	999988	861674	138326	393101	999867	393234	606766
878695	999988	878708	121292	398179	999864	398315	601685
895685	999987	895699	104901	403199	999861	403338	596662
910879	999986	910894	089106	408161	999858	408304	591696
926119	999985	926134	073866	413068	999854	413213	586787
940842	999983	940858	059142	417919	999851	418068	581932
7.965082	9.999982	7.965100	12.044900	8.422717	9.999848	8.422869	11.577131
968870	999981	968889	031111	427462	999844	427618	572382
982233	999980	982253	017747	432156	999841	432315	567685
995198	999979	995219	004781	436800	999838	436962	563038
0.007787	999977	8.007809	11.992191	441394	999834	441560	558440
020021	999976	020045	979955	445941	999831	446110	553890
031919	999975	031945	968055	450440	999827	450613	549387
043501	999973	043527	956473	454893	999823	455070	544930
054781	999972	054809	945191	459301	999820	459481	540519
065776	999971	065806	934194	463665	999816	463849	536151
8.076500	9.999969	8.076531	11.923469	8.467985	9.999812	8.468172	11.531828
086965	999968	086997	913003	472263	999809	472454	527546
097183	999966	097217	902783	476498	999805	476693	523307
107167	999964	107202	892797	480693	999801	480892	519108
116926	999963	116963	883037	484848	999797	485050	514950
126471	999961	126510	873490	488963	999793	489170	510830
135819	999959	135851	864149	493040	999790	493250	506750
144953	999958	144996	855004	497078	999786	497293	502707
153907	999956	153952	846048	501080	999782	501298	498702
162681	999954	162727	837273	505045	999778	505267	494733
8.171289	9.999952	8.171328	11.828672	8.508974	9.999774	8.509200	11.490800
179713	999950	179763	820237	512867	999769	513093	486902
187995	999948	188036	811964	516726	999765	516961	483039
196102	999946	196156	803844	520551	999761	520790	479210
204070	999944	204126	795874	524343	999757	524586	475414
211895	999942	211953	788047	528102	999753	528349	471651
219581	999940	219641	780359	531828	999748	532080	467920
227134	999938	227195	772805	535523	999744	535779	464221
234557	999936	234621	765379	539186	999740	539447	460553
241856	999934	241921	758079	542819	999735	543084	456916
Cosine.	Sine.	Cotang.	Tang.	Cosine.	Sine.	Cotang.	Tang.
89 Degrees.				88 Degrees.			

2 Degrees.					3 Degrees.			
	Sine.	Cosine.	Tang.	Cotang.	Sine.	Cosine.	Tang.	Cotang.
0	8.542819	9.999735	8.543084	11.456916	8.718800	9.999404	8.719396	11.230
1	546422	999731	546691	453309	721204	999398	721806	271
2	549995	999726	550268	449732	723595	999391	724204	275
3	553539	999722	553817	446183	725972	999384	726563	278
4	557084	999717	557336	442664	728337	999378	728959	271
5	560540	999713	560828	439172	730688	999371	731317	268
6	563999	999708	564291	435709	733027	999364	733683	266
7	567431	999704	567727	432273	735354	999357	735996	264
8	570836	999699	571137	428863	737667	999350	738317	261
9	574214	999694	574520	425480	739969	999343	740626	259
10	577566	999689	577877	422123	742259	999336	742922	257
11	580892	9.999685	581208	11.418792	8.744536	9.999329	8.745207	11.254
12	584193	999680	584514	415486	746802	999322	747479	252
13	587469	999675	587795	412205	749055	999315	749740	250
14	590721	999670	591051	408949	751297	999308	751989	248
15	593948	999665	594283	405717	753528	999301	754227	245
16	597152	999660	597492	402508	755747	999294	756453	243
17	600332	999655	600677	399323	757955	999286	758668	241
18	603489	999650	603839	396161	760151	999279	760872	239
19	606623	999645	606978	393022	762337	999272	763065	236
20	609734	999640	610094	389906	764511	999265	765246	234
21	612823	9.999635	613189	11.386811	8.766675	9.999257	8.767417	11.232
22	615891	999629	616262	386738	766828	999250	769578	230
23	618937	999624	619313	383687	770970	999242	771727	228
24	621962	999619	622343	377657	773101	999235	773866	226
25	624965	999614	625352	374648	775223	999227	775995	224
26	627948	999608	628340	371660	777333	999220	778114	221
27	630911	999603	631308	368692	779434	999212	780222	219
28	633854	999597	634256	365744	781524	999205	782320	217
29	636776	999592	637184	362816	783605	999197	784408	215
30	639680	999586	640093	359907	785675	999189	786486	213
31	642563	9.999581	642982	11.357018	8.787736	9.999181	8.788554	11.211
32	645428	999575	645853	354147	789787	999174	790613	209
33	648274	999570	648704	351296	791828	999166	792602	207
34	651102	999564	651537	348463	793859	999158	794701	205
35	653911	999558	654352	345648	795881	999150	796731	203
36	656702	999553	657149	342851	797894	999142	798752	201
37	659475	999547	659928	340072	799897	999134	800763	199
38	662230	999541	662639	337311	801892	999126	802765	197
39	664968	999535	665433	334567	803876	999118	804758	195
40	667689	999529	668160	331840	805852	999110	806742	193
41	670393	9.999524	670870	11.329130	8.807819	9.999102	8.808717	11.19
42	673080	999518	673563	326437	809777	999094	810683	189
43	675751	999512	676239	323761	811726	999086	812641	187
44	678405	999506	678900	321100	813667	999077	814589	185
45	681043	999500	681544	318456	815599	999069	816529	183
46	683665	999493	684172	315828	817522	999061	818461	181
47	686272	999487	686784	313216	819436	999053	820384	179
48	688863	999481	689381	310619	821343	999044	822298	177
49	691438	999475	691963	308037	823240	999036	824205	175
50	693998	999469	694529	305471	825130	999027	826103	173
51	696543	9.999463	697081	11.302919	8.827011	9.999019	8.827892	11.17
52	699073	999456	699617	300383	828884	999010	828874	171
53	701589	999450	702139	297861	830749	999002	831748	169
54	704090	999443	704646	295354	832607	998993	833613	167
55	706577	999437	707140	292860	834456	998984	835471	165
56	709049	999431	709618	290382	836297	998976	837321	163
57	711507	999424	712083	287917	838130	998967	839163	161
58	713952	999418	714534	285465	839956	998958	840998	159
59	716383	999411	716972	283028	841774	998950	842825	157
60	718800	999404	719396	280604	843585	998941	844644	155
	Cosine.	Sine.	Cotang.	Tang.	Cosine.	Sine.	Cotang.	
87 Degrees.					88 Degrees.			

4 Degrees.				5 Degrees.			
no.	Cosine.	Tang.	Cotang.	Sine.	Cosine.	Tang.	Cotang.
3585	9.998941	8.844644	11.155356	8.940296	9.998344	8.941952	11.058048
5387	9.998932	846455	153545	941738	998333	943404	056596
7183	9.998923	848260	151740	943174	998322	944852	055148
8971	9.998914	850057	149943	944606	998311	946295	053705
0751	9.998905	851846	148154	946034	998300	947734	052266
2525	9.998896	853628	146372	947456	998289	949168	050832
4291	9.998887	855403	144597	948874	998277	950597	049403
6049	9.998878	857171	142829	950287	998266	952021	047979
7801	9.998869	858932	141068	951696	998255	953441	046559
9546	9.998860	860696	139314	953100	998243	954856	045144
1283	9.998851	862433	137567	954499	998232	956267	043733
3014	9.998841	8.864173	11.135827	8.955894	9.998220	8.957674	11.042326
4738	9.998832	865906	134094	957284	998209	959075	040925
6455	9.998823	867632	132368	958670	998197	960473	039527
8165	9.998813	869351	130649	960052	998186	961866	038134
9868	9.998804	871064	128936	961429	998174	963255	036745
1565	9.998795	872770	127230	962801	998163	964639	035361
3255	9.998785	874469	125531	964170	998151	966019	033981
4936	9.998776	876162	123838	965534	998139	967394	032606
6615	9.998766	877849	122151	966893	998128	968766	031234
8285	9.998757	879529	120471	968249	998116	970133	029867
9949	9.998747	8.881202	11.118798	8.969600	9.998104	8.971496	11.028504
1607	9.998738	882869	117131	970947	998092	972855	027145
3258	9.998728	884530	115470	972289	998080	974209	025791
4903	9.998718	886185	113815	973628	998068	975560	024440
6542	9.998708	887833	112167	974962	998056	976906	023094
8174	9.998699	889476	110524	976293	998044	978248	021752
9801	9.998689	891112	108888	977619	998032	979586	020414
1421	9.998679	892742	107258	978941	998020	980921	019079
3035	9.998669	894366	105634	980259	998008	982251	017749
4643	9.998659	895984	104016	981573	997996	983577	016423
6246	9.998649	8.897596	11.102404	8.982883	9.997984	8.984899	11.015101
7842	9.998639	899203	100797	984189	997972	986217	015083
9432	9.998629	900803	999197	985491	997959	987532	012468
1017	9.998619	902398	997602	986789	997947	988842	011158
2596	9.998609	903987	996013	988083	997935	990149	009851
4169	9.998599	905570	994430	989374	997922	991451	008549
5736	9.998589	907147	992853	990660	997910	992750	007250
7297	9.998578	908719	991281	991943	997897	994045	005955
8853	9.998568	910285	989715	993222	997885	995337	004663
1404	9.998558	911846	988154	994497	997872	996624	003376
3049	9.998548	8.913401	11.086599	8.995768	9.997860	8.997908	11.002092
4683	9.998537	914951	986504	997036	997847	999188	000812
6322	9.998527	916495	983505	998299	997835	9.000465	10.999535
7950	9.998516	918034	981966	999560	997822	001738	998262
9573	9.998506	919568	980432	9.000816	997809	003007	996993
1591	9.998495	921096	978904	002069	997797	004272	995728
3213	9.998485	922619	977381	003318	997784	005534	994466
4810	9.998474	924136	975864	004563	997771	006792	993208
6412	9.998464	925649	974351	005805	997758	008047	991953
8009	9.998453	927156	972844	007044	997745	009298	990702
9610	9.998442	8.928658	11.071342	9.008278	9.997732	9.010546	10.989454
1587	9.998431	930155	969845	009510	997719	011790	988210
3268	9.998421	931647	968353	010737	997706	013031	986969
4944	9.998410	933134	966866	011962	997693	014268	985732
6615	9.998399	934616	965384	013182	997680	015502	984498
8281	9.998388	936093	963907	014400	997667	016732	983268
9942	9.998377	937565	962435	015613	997654	017953	982041
1608	9.998366	939032	960968	016824	997641	019183	980817
3250	9.998355	940494	959506	018031	997628	020403	979597
4906	9.998344	941952	958048	019235	997614	021620	978380
e.	Sine.	Cotang.	Tang.	Cosine.	Sine.	Cotang.	Tang.
85 Degrees.				84 Degrees.			

6 Degrees.										7 Degrees.									
N.	Sine.	Cosine.	Tang.	Cotang.	Sine.	Cosine.	Tang.	Cotang.	N.	Sine.	Cosine.	Tang.	Cotang.	N.	Sine.	Cosine.	Tang.	Cotang.	N.
0	9.019235	9.997614	9.021620	10.971380	9.085944	9.996751	9.089144	10.910856	1	020435	9.997601	0.22834	9.77166	0.086922	9.996735	0.90187	9.09813	10.90187	1
2	021632	9.997588	0.24044	9.75956	0.087947	9.996720	0.91228	9.08772	2	022825	9.997574	0.251	9.74749	0.088970	9.996704	0.92266	9.07734	10.92266	2
3	024016	9.997561	0.26455	9.73545	0.089990	9.996688	0.93302	9.07698	3	025203	9.997547	0.27655	9.72345	0.091008	9.996673	0.94336	9.06664	10.94336	3
4	026386	9.997534	0.28852	9.71148	0.092024	9.996657	0.95367	9.05633	4	027567	9.997520	0.30046	9.69954	0.093037	9.996641	0.96395	9.04669	10.96395	4
5	028744	9.997507	0.31237	9.68763	0.094047	9.996625	0.97422	9.03697	5	029918	9.997493	0.32425	9.67575	0.095056	9.996610	0.98446	9.02754	10.98446	5
6	031089	9.997480	0.33609	9.66391	0.096062	9.996594	0.99468	9.01836	6	032257	9.997466	0.34791	10.965209	9.097065	9.996578	9.100487	10.89951	10.99951	6
7	033421	9.997452	0.35969	9.64031	0.098066	9.996562	10.1504	8.99951	7	034582	9.997439	0.37144	9.6256	0.099065	9.996546	10.2519	8.98951	10.98951	7
8	035741	9.997425	0.38316	9.61684	0.100062	9.996530	10.3532	8.97951	8	036896	9.997411	0.39485	9.60515	0.101056	9.996514	10.4542	8.96951	10.96951	8
9	038048	9.997397	0.40651	9.59349	0.102048	9.996498	10.5550	8.95951	9	039197	9.997383	0.41813	9.58187	0.103037	9.996482	10.6556	8.94951	10.94951	9
10	040342	9.997369	0.42973	9.57027	0.104025	9.996465	10.7559	8.93951	10	041485	9.997355	0.44130	9.55870	0.105010	9.996449	10.8560	8.92951	10.92951	10
11	042625	9.997341	0.45284	9.54716	0.105992	9.996433	10.9559	8.91951	11	043762	9.997327	0.46434	10.953566	9.106973	9.996417	9.110556	10.89951	10.89951	11
12	044895	9.997313	0.47582	9.52418	0.107951	9.996400	11.1551	8.90951	12	046026	9.997299	0.48727	9.51273	0.108927	9.996384	11.2543	8.89951	10.89951	12
13	047154	9.997285	0.49869	9.50131	0.109901	9.996368	11.3533	8.88951	13	048279	9.997271	0.51008	9.48992	0.110873	9.996351	11.4521	8.87951	10.87951	13
14	049400	9.997257	0.52144	9.47856	0.111842	9.996335	11.5507	8.86951	14	050519	9.997242	0.53277	9.46723	0.112809	9.996318	11.6491	8.85951	10.85951	14
15	051635	9.997228	0.54407	9.45593	0.113774	9.996302	11.7472	8.84951	15	052749	9.997214	0.55535	9.44465	0.114737	9.996285	11.8452	8.83951	10.83951	15
16	053859	9.997199	0.56659	9.43341	0.115698	9.996269	11.9429	8.82951	16	054966	9.997185	0.57781	10.942219	9.116656	9.996252	9.120404	10.89951	10.89951	16
17	056071	9.997170	0.58900	9.41100	0.117613	9.996235	12.1377	8.81951	17	057172	9.997156	0.60016	9.39984	0.118567	9.996219	12.2348	8.80951	10.80951	17
18	058271	9.997141	0.61130	9.38870	0.119519	9.996202	12.3317	8.79951	18	059367	9.997127	0.62240	9.37760	0.120469	9.996185	12.4284	8.78951	10.78951	18
19	060460	9.997112	0.63348	9.36652	0.121417	9.996168	12.5249	8.77951	19	061551	9.997098	0.64453	9.35547	0.122362	9.996151	12.6211	8.76951	10.76951	19
20	061551	9.997098	0.64453	9.35547	0.122362	9.996151	12.6211	8.75951	20	062639	9.997083	0.65556	9.34444	0.123306	9.996134	12.7172	8.74951	10.74951	20
21	062639	9.997083	0.65556	9.34444	0.123306	9.996134	12.7172	8.73951	21	063724	9.997068	0.66655	9.33345	0.124248	9.996117	12.8130	8.72951	10.72951	21
22	063724	9.997068	0.66655	9.33345	0.124248	9.996117	12.8130	8.71951	22	064806	9.997053	0.67752	9.32248	0.125187	9.996100	12.9087	8.70951	10.70951	22
23	064806	9.997053	0.67752	9.32248	0.125187	9.996100	12.9087	8.69951	23	065885	9.997039	0.68846	10.931154	9.126125	9.996083	9.130041	10.89951	10.89951	23
24	065885	9.997039	0.68846	10.931154	9.126125	9.996083	9.130041	10.89951	24	066962	9.997024	0.69938	9.90062	0.127060	9.996066	13.0994	8.68951	10.68951	24
25	066962	9.997024	0.69938	9.90062	0.127060	9.996066	13.0994	8.67951	25	068036	9.997009	0.71027	9.88973	0.127993	9.996049	13.1944	8.66951	10.66951	25
26	068036	9.997009	0.71027	9.88973	0.127993	9.996049	13.1944	8.65951	26	069107	9.996994	0.72113	9.87887	0.128925	9.996032	13.2893	8.64951	10.64951	26
27	069107	9.996994	0.72113	9.87887	0.128925	9.996032	13.2893	8.63951	27	070176	9.996979	0.73197	9.86803	0.129854	9.996015	13.3839	8.62951	10.62951	27
28	070176	9.996979	0.73197	9.86803	0.129854	9.996015	13.3839	8.61951	28	071242	9.996964	0.74278	9.85722	0.130781	9.995998	13.4784	8.60951	10.60951	28
29	071242	9.996964	0.74278	9.85722	0.130781	9.995998	13.4784	8.59951	29	072306	9.996949	0.75356	9.84644	0.131706	9.995980	13.5726	8.58951	10.58951	29
30	072306	9.996949	0.75356	9.84644	0.131706	9.995980	13.5726	8.57951	30	073366	9.996934	0.76432	9.83568	0.132630	9.995963	13.6667	8.56951	10.56951	30
31	073366	9.996934	0.76432	9.83568	0.132630	9.995963	13.6667	8.55951	31	074424	9.996919	0.77505	9.82495	0.133551	9.995946	13.7605	8.54951	10.54951	31
32	074424	9.996919	0.77505	9.82495	0.133551	9.995946	13.7605	8.53951	32	075480	9.996904	0.78576	9.81424	0.134470	9.995928	13.8542	8.52951	10.52951	32
33	075480	9.996904	0.78576	9.81424	0.134470	9.995928	13.8542	8.51951	33	076533	9.996889	0.79644	10.920356	9.135387	9.995911	9.139476	10.89951	10.89951	33
34	076533	9.996889	0.79644	10.920356	9.135387	9.995911	9.139476	10.89951	34	077583	9.996874	0.80710	9.80290	0.136303	9.995894	14.0409	8.50951	10.50951	34
35	077583	9.996874	0.80710	9.80290	0.136303	9.995894	14.0409	8.49951	35	078631	9.996858	0.81773	9.79227	0.137216	9.995876	14.1340	8.48951	10.48951	35
36	078631	9.996858	0.81773	9.79227	0.137216	9.995876	14.1340	8.47951	36	079676	9.996843	0.82833	9.78167	0.138128	9.995859	14.2269	8.46951	10.46951	36
37	079676	9.996843	0.82833	9.78167	0.138128	9.995859	14.2269	8.45951	37	080719	9.996828	0.83891	9.77109	0.139037	9.995841	14.3196	8.44951	10.44951	37
38	080719	9.996828	0.83891	9.77109	0.139037	9.995841	14.3196	8.43951	38	081759	9.996812	0.84947	9.76053	0.139944	9.995823	14.4121	8.42951	10.42951	38
39	081759	9.996812	0.84947	9.76053	0.139944	9.995823	14.4121	8.41951	39	082797	9.996797	0.86000	9.75000	0.140850	9.995806	14.5044	8.40951	10.40951	39
40	082797	9.996797	0.86000	9.75000	0.140850	9.995806	14.5044	8.39951	40	083832	9.996782	0.87050	9.73950	0.141754	9.995788	14.5966	8.38951	10.38951	40
41	083832	9.996782	0.87050	9.73950	0.141754	9.995788	14.5966	8.37951	41	084864	9.996766	0.88098	9.72902	0.142655	9.995771	14.6885	8.36951	10.36951	41
42	084864	9.996766	0.88098	9.72902	0.142655	9.995771	14.6885	8.35951	42	085894	9.996751	0.89144	9.71856	0.143555	9.995753	14.7803	8.34951	10.34951	42
43	085894	9.996751	0.89144	9.71856	0.143555	9.995753	14.7803	8.33951	43										
83 Degrees.										82 Degrees.									
Cosine.					Sine.					Cosine.					Sine.				

8 Degrees.				9 Degrees.			
De.	Cosine.	Tang.	Cotang.	Sine.	Cosine.	Tang.	Cotang.
555	9.995753	9.147803	10.852197	9.194332	9.994620	9.190713	10.800287
556	9.995735	148718	851282	195129	994600	200529	799471
557	9.995717	149632	850368	195925	994580	201345	798655
558	9.995699	150544	849456	196719	994560	202159	797841
559	9.995681	151454	848546	197511	994540	202971	797029
560	9.995664	152363	847637	198302	994519	203782	796218
561	9.995646	153269	846731	199091	994499	204592	795408
562	9.995628	154174	845826	199879	994479	205400	794600
563	9.995610	155077	844923	200666	994459	206207	793793
564	9.995591	155978	844022	201451	994438	207013	792987
565	9.995573	156877	843123	202234	994418	207817	792183
566	9.995555	9.157775	10.842225	9.203017	9.994398	9.208619	10.791381
567	9.995537	158671	841329	203797	994377	209420	790580
568	9.995519	159565	840435	204577	994357	210220	789780
569	9.995501	160457	839543	205354	994336	211018	788982
570	9.995482	161347	838653	206131	994316	211815	788185
571	9.995464	162236	837764	206906	994295	212611	787389
572	9.995446	163123	836877	207679	994274	213405	786595
573	9.995427	164008	835992	208452	994254	214198	785802
574	9.995409	164892	835108	209222	994233	214989	785011
575	9.995390	165774	834226	209992	994212	215780	784220
576	9.995372	9.166654	10.833346	9.210760	9.994191	9.216568	10.783432
577	9.995353	167632	832438	211526	994171	217356	782644
578	9.995334	168409	831591	212291	994150	218142	781858
579	9.995316	169284	830716	213055	994129	218926	781074
580	9.995297	170157	829843	213818	994108	219710	780290
581	9.995278	171029	828971	214579	994087	220492	779508
582	9.995260	171899	828101	215338	994066	221272	778728
583	9.995241	172767	827233	216097	994045	222052	777948
584	9.995222	173634	826366	216854	994024	222830	777170
585	9.995203	174499	825501	217609	994003	223607	776393
586	9.995184	9.175362	10.824638	9.218363	9.993982	9.224382	10.775618
587	9.995165	176224	823776	219116	993960	225156	774844
588	9.995146	177084	822916	219868	993939	225929	774071
589	9.995127	177942	822058	220618	993918	226700	773300
590	9.995108	178799	821201	221367	993897	227471	772529
591	9.995089	179655	820345	222115	993875	228239	771761
592	9.995070	180508	819492	222861	993854	229007	770993
593	9.995051	181360	818640	223606	993832	229773	770227
594	9.995032	182211	817789	224349	993811	230539	769461
595	9.995013	183059	816941	225092	993789	231302	768698
596	9.994993	9.183907	10.816093	9.225833	9.993768	9.232065	10.767935
597	9.994974	184752	815248	225873	993746	232826	767174
598	9.994955	185597	814403	226731	993725	233586	766414
599	9.994935	186439	813561	227488	993703	234345	765655
600	9.994916	187280	812720	228244	993681	235103	764897
601	9.994896	188120	811880	229000	993660	235861	764141
602	9.994877	188958	811042	229755	993638	236614	763386
603	9.994857	189794	810206	230509	993616	237368	762632
604	9.994838	190629	809371	231274	993594	238120	761880
605	9.994818	191462	808538	232044	993572	238872	761128
606	9.994798	9.192294	10.807706	9.233172	9.993550	9.239622	10.760378
607	9.994779	193124	806876	232899	993528	240371	759629
608	9.994759	193953	806047	233625	993506	241118	758882
609	9.994739	194780	805220	234359	993484	241865	758135
610	9.994719	195606	804394	235073	993462	242610	757390
611	9.994700	196430	803570	235795	993440	243354	756646
612	9.994680	197253	802747	236515	993418	244097	755903
613	9.994660	198074	801926	237235	993396	244839	755161
614	9.994640	198894	801106	237953	993374	245579	754421
615	9.994620	199713	800287	238670	993351	246319	753681
De.	Sine.	Cotang.	Tang.	Cosine.	Sine.	Cotang.	Tang.
81 Degrees.				80 Degrees.			

10 Degrees.				11 Degrees.			
Sine.	Cosine.	Tang.	Cotang.	Sine.	Cosine.	Tang.	Cot.
0 9.239670	9.993351	9.246319	10.753681	9.280599	9.991947	9.288652	10.71
1 240386	993329	247057	752943	281248	991922	289326	71
2 241101	993307	247794	752206	281897	991897	289999	71
3 241814	993284	248530	751470	282544	991873	290671	70
4 242526	993262	249264	750736	283190	991848	291342	70
5 243237	993240	249998	750002	283836	991823	292013	70
6 243947	993217	250730	749270	284480	991799	292682	70
7 244656	993195	251461	748539	285124	991774	293350	70
8 245363	993172	252191	747809	285766	991749	294017	70
9 246069	993149	252920	747080	286408	991724	294684	70
10 246775	993127	253648	746352	287048	991699	295349	70
11 9.247478	9.993104	9.254374	10.745626	9.287687	9.991674	9.296013	10.70
12 248181	993081	255100	744900	288326	991649	296677	70
13 248883	993059	255824	744176	288964	991624	297339	70
14 249583	993036	256547	743453	289600	991599	298001	70
15 250282	993013	257269	742731	290236	991574	298662	70
16 250980	992990	257990	742010	290870	991549	299322	70
17 251677	992967	258710	741290	291504	991524	299980	70
18 252373	992944	259429	740571	292137	991498	300638	69
19 253067	992921	260146	739854	292768	991473	301295	69
20 253761	992898	260863	739137	293399	991448	301951	69
21 9.254453	9.992875	9.261578	10.738422	9.294029	9.991422	9.302607	10.69
22 255144	992852	262292	737708	294658	991397	303261	69
23 255834	992829	263005	736995	295286	991372	303914	69
24 256523	992806	263717	736283	295913	991346	304567	69
25 257211	992783	264428	735572	296539	991321	305218	69
26 257898	992759	265138	734862	297164	991295	305869	69
27 258583	992736	265847	734153	297788	991270	306519	69
28 259268	992713	266555	733445	298412	991244	307168	69
29 259951	992690	267261	732739	299034	991218	307815	69
30 260633	992666	267967	732033	299655	991193	308463	69
31 9.261314	9.992643	9.268671	10.731329	9.300276	9.991167	9.309109	10.68
32 261994	992619	269375	730625	300895	991141	309754	68
33 262673	992596	270077	729923	301514	991115	310398	68
34 263351	992572	270779	729221	302132	991090	311042	68
35 264027	992549	271479	728521	302748	991064	311685	68
36 264703	992525	272178	727822	303364	991038	312327	68
37 265377	992501	272876	727124	303979	991012	312967	68
38 266051	992478	273573	726427	304593	990986	313608	68
39 266723	992454	274269	725731	305207	990960	314247	68
40 267395	992430	274964	725036	305819	990934	314885	68
41 9.268065	9.992406	9.275658	10.724342	9.306430	9.990908	9.315523	10.68
42 268734	992382	275651	723649	307041	990882	316159	68
43 269402	992359	277043	722957	307650	990855	316795	68
44 270069	992335	277734	722266	308259	990829	317430	68
45 270735	992311	278424	721576	308867	990803	318064	68
46 271400	992287	279113	720887	309474	990777	318697	68
47 272064	992263	279801	720199	310080	990750	319329	68
48 272726	992239	280488	719512	310685	990724	319961	68
49 273388	992214	281174	718826	311289	990697	320592	67
50 274049	992190	281858	718142	311893	990671	321222	67
51 9.274708	9.992166	9.282542	10.717458	9.312495	9.990644	9.321851	10.67
52 275367	992142	283225	716775	313097	990618	322479	67
53 276024	992118	283907	716093	313698	990591	323106	67
54 276681	992093	284588	715412	314297	990565	323733	67
55 277337	992069	285268	714732	314897	990538	324358	67
56 277991	992044	285947	714053	315495	990511	324983	67
57 278645	992020	286624	713376	316092	990485	325607	67
58 279297	991996	287301	712699	316689	990458	326231	67
59 279948	991971	287977	712023	317284	990431	326855	67
60 280599	991947	288652	711348	317879	990404	327479	67
2 Cosine.	Sine.	Cotang.	Tang.	Cosine.	Sine.	Cotang.	
79 Degrees.				78 Degrees.			

12 Degrees.				13 Degrees.			
s.	Cosine.	Tang.	Cotang.	Sine.	Cosine.	Tang.	Cotang.
379	9.990404	9.327474	10.672526	9.352088	9.988724	9.363364	10.636636
473	990378	328095	671905	352635	988695	363940	636060
666	990351	328715	671285	353181	988666	364515	635485
658	990324	329334	670666	353726	988636	365090	634910
249	990297	329953	670047	354271	988607	365664	634336
840	990270	330570	669430	354815	988578	366237	633763
430	990243	331187	668813	355358	988548	366810	633190
019	990215	331803	668197	355901	988519	367382	632618
607	990188	332418	667582	356443	988489	367953	632047
194	990161	333033	666967	356984	988460	368524	631476
780	990134	333646	666354	357524	988430	369094	630906
366	9.990107	9.334259	10.665741	9.358064	9.988401	9.369663	10.630337
950	990079	334871	665129	358603	988371	370232	629768
534	990052	335482	664518	359141	988342	370799	629201
117	990025	336093	663907	359678	988312	371367	628633
700	989997	336702	663298	360215	988282	371933	628067
281	989970	337311	662689	360752	988252	372499	627501
862	989942	337919	662081	361287	988223	373064	626936
442	989915	338527	661473	361822	988193	373629	626371
021	989887	339133	660867	362356	988163	374193	625807
699	989860	339739	660261	362889	988133	374756	625244
176	9.989832	9.340344	10.659656	9.363422	9.988103	9.375319	10.624681
753	989804	340948	659052	363954	988073	375381	624119
329	989777	341552	658448	364485	988043	376442	623557
903	989749	342155	657845	365016	988013	377003	622997
478	989721	342757	657243	365546	987983	377563	622437
051	989693	343358	656642	366075	987953	378122	621874
624	989665	343958	656042	366604	987922	378681	621319
195	989637	344558	655442	367131	987892	379239	620761
766	989609	345157	654843	367659	987862	379797	620203
337	989582	345755	654245	368185	987832	380354	619646
906	9.989553	9.346353	10.653647	9.368711	9.987801	9.380910	10.619090
475	989525	346349	653051	369236	987771	381466	618534
7043	989497	347545	652455	369761	987740	382020	617980
7610	989469	348141	651859	370285	987710	382575	617425
8176	989441	348735	651265	370808	987679	383129	616871
8742	989413	349329	650671	371330	987649	383682	616318
9307	989385	349922	650078	371852	987618	384234	615766
9871	989356	350514	649486	372373	987588	384786	615214
0434	989328	351106	648894	372894	987557	385337	614663
0996	989300	351697	648303	373414	987526	385888	614112
1558	9.989271	9.352267	10.647713	9.373933	9.987496	9.386438	10.613562
2119	989243	352876	647124	374452	987465	386987	613013
2679	989214	353465	646535	374970	987434	387536	612464
3239	989186	354053	645947	375487	987403	388084	611916
3797	989157	354640	645360	376003	987372	388631	611369
4355	989128	355227	644773	376519	987341	389178	610822
4912	989100	355813	644187	377035	987310	389724	610276
5469	989071	356398	643602	377549	987279	390270	609730
6024	989042	356982	643018	378063	987248	390815	609185
6579	989014	357566	642434	378577	987217	391360	608640
7134	9.988935	9.358149	10.641851	9.379089	9.987186	9.391903	10.608097
7687	988956	358731	641869	379601	987155	392447	607553
8240	988927	359313	640687	380113	987124	392989	607011
8792	988898	359893	640107	380624	987092	393531	606469
9343	988869	360474	639526	381134	987061	394073	605927
9893	988840	361053	638947	381643	987030	394614	605386
0443	988811	361632	638368	382152	986998	395154	604846
0992	988782	362210	637790	382661	986967	395694	604306
1540	988753	362787	637213	383168	986936	396233	603767
2098	988724	363364	636636	383675	986904	396771	603229
s.	Sine.	Cotang.	Tang.	Cosine.	Sine.	Cotang.	Tang.
77 Degrees.				76 Degrees.			

14 Degrees.				15 Degrees.			
Sine.	Cosine.	Tang.	Cotang.	Sine.	Cosine.	Tang.	Cot.
0 9.383675	9.986904	9.396771	10.603229	9.412996	9.984944	9.428052	10.5
1 384182	986 73	397309	602691	413467	984910	428557	5
2 384687	986841	397846	602154	413938	984876	429062	5
3 385192	986809	398383	601617	414408	984842	429566	5
4 385697	986778	398919	601081	414878	984808	430070	5
5 386201	986746	399455	600545	415347	984774	430573	5
6 386704	986714	399990	600010	415815	984740	431075	5
7 387207	986683	400524	599476	416283	984706	431577	5
8 387709	986651	401058	598942	416751	984672	432079	5
9 388210	986619	401591	598409	417217	984638	432580	5
10 388711	986587	402124	597876	417684	984603	433080	5
11 9.389211	9.986555	9.402656	10.597344	9.418150	9.984569	9.433580	10.5
12 389711	986523	403187	596813	418615	984535	434080	5
13 390210	986491	403718	596282	419079	984500	434579	5
14 390708	986459	404249	595751	419544	984466	435078	5
15 391206	986427	404778	595222	420007	984432	435576	5
16 391703	986395	405308	594692	420470	984397	436073	5
17 392199	986363	405836	594164	420933	984363	436570	5
18 392695	986331	406364	593636	421395	984328	437067	5
19 393191	986299	406892	593108	421857	984294	437563	5
20 393685	986266	407419	592581	422318	984259	438059	5
21 9.394179	9.986234	9.407945	10.592055	9.422778	9.984224	9.438554	10.5
22 394673	986202	408471	591529	423238	984190	439048	5
23 395166	986169	408997	591003	423697	984155	439543	5
24 395658	986137	409521	590479	424156	984120	440036	5
25 396150	986104	410045	589955	424615	984085	440529	5
26 396641	986072	410569	589431	425073	984050	441022	5
27 397132	986039	411092	588908	425530	984015	441514	5
28 397621	986007	411615	588385	425987	983981	442006	5
29 398111	985974	412137	587863	426443	983946	442497	5
30 398600	985942	412658	587342	426899	983911	442988	5
31 9.399088	9.985909	9.413179	10.586821	9.427354	9.983875	9.443479	10.5
32 399575	985876	413699	586801	427809	983840	443968	5
33 400062	985843	414219	586278	428263	983805	444458	5
34 400549	985811	414738	585752	428717	983770	444947	5
35 401035	985778	415257	585225	429170	983735	445435	5
36 401520	985745	415775	584698	429623	983700	445923	5
37 402005	985712	416293	584170	430075	983664	446411	5
38 402489	985679	416810	583643	430527	983629	446898	5
39 402972	985646	417326	583115	430978	983594	447384	5
40 403455	985613	417842	582588	431429	983558	447870	5
41 9.403938	9.985580	9.418358	10.581642	9.431879	9.983523	9.448356	10.5
42 404420	985547	418373	581127	432329	983487	448841	5
43 404901	985514	419387	580613	432778	983452	449326	5
44 405382	985480	419901	580099	433226	983416	449810	5
45 405862	985447	420415	579585	433675	983381	450294	5
46 406341	985414	420927	579073	434122	983345	450777	5
47 406820	985381	421440	578560	434569	983309	451260	5
48 407299	985347	421952	578048	435016	983273	451743	5
49 407777	985314	422463	577537	435462	983238	452225	5
50 408254	985280	422974	577026	435908	983202	452706	5
51 9.408731	9.985247	9.423484	10.576516	9.436353	9.983166	9.453187	10.5
52 409207	985213	423993	576507	436798	983130	453668	5
53 409682	985180	424503	575997	437242	983094	454148	5
54 410157	985146	425011	575488	437686	983058	454628	5
55 410632	985113	425519	574981	438129	983022	455107	5
56 411106	985079	426027	574473	438572	982986	455586	5
57 411579	985045	426534	573966	439014	982950	456064	5
58 412052	985011	427041	573459	439456	982914	456542	5
59 412524	984978	427547	572953	439897	982878	457019	5
60 412996	984944	428052	572448	440338	982842	457496	5
Cosine.	Sine.	Cotang.	Tang.	Cosine.	Sine.	Cotang.	
76 Degrees.				74 Degrees.			

16 Degrees.			17 Degrees.		
Cosine.	Tang.	Cotang.	Sine.	Cosine.	Tang.
982842	9.457496	10.542504	9.465935	9.980596	9.485339
982805	457973	542027	466348	980558	485791
982769	458449	541551	466761	980519	486242
982733	458925	541075	467173	980480	486693
982696	459400	540600	467585	980442	487143
982660	459875	540125	467996	980403	487593
982624	460349	539651	468407	980364	488043
982587	460823	539177	468817	980325	488492
982551	461297	538703	469227	980286	488941
982514	461770	538230	469637	980247	489390
982477	462242	537758	470046	980208	489838
982441	9.462714	10.537286	9.470455	9.980169	9.490286
982404	463186	536814	470863	980130	490733
982367	463658	536342	471271	980091	491180
982331	464129	535872	471679	980052	491627
982294	464599	535401	472086	980012	492073
982257	465069	534931	472492	979973	492519
982220	465538	534461	472898	979934	492965
982183	466008	533992	473304	979895	493410
982146	466476	533524	473710	979855	493854
982109	466945	533055	474115	979816	494299
982072	9.467413	10.532587	9.474519	9.979776	9.494743
982035	467880	532120	474923	979737	495186
981998	468347	531653	475327	979697	495630
981961	468814	531186	475730	979658	496073
981924	469280	530720	476133	979618	496515
981886	469746	530254	476536	979579	496957
981849	470211	529789	476938	979539	497399
981812	470676	529324	477340	979499	497841
981774	471141	528859	477741	979459	498282
981737	471605	528395	478142	979420	498722
981700	9.472068	10.527932	9.478542	9.979380	9.499163
981662	472532	527468	478942	979340	499603
981625	472995	527005	479342	979300	500042
981587	473457	526543	479741	979260	500481
981549	473919	526081	480140	979220	500920
981512	474381	525619	480539	979180	501359
981474	474842	525158	480937	979140	501797
981436	475303	524697	481334	979100	502235
981399	475763	524237	481731	979059	502672
981361	476223	523777	482128	979019	503109
981323	9.476683	10.523317	9.482525	9.978979	9.503546
981285	477142	522858	482921	978939	503982
981247	477601	522399	483316	978898	504418
981209	478059	521941	483712	978858	504854
981171	478517	521483	484107	978817	505289
981133	478975	521025	484501	978777	505724
981095	479432	520568	484895	978737	506159
981057	479889	520111	485289	978696	506593
981019	480345	519655	485682	978655	507027
980981	480801	519199	486075	978615	507460
980942	9.481257	10.518743	9.486467	9.978574	9.507893
980904	481712	518288	486860	978533	508326
980866	482167	517833	487251	978493	508759
980827	482621	517379	487643	978452	509191
980789	483075	516925	488034	978411	509622
980750	483529	516471	488424	978370	510054
980712	483982	516018	488814	978329	510485
980673	484435	515565	489204	978288	510916
980635	484887	515113	489593	978247	511346
980596	485339	514661	489982	978206	511776
Sine. Cotang. Tang.			Cosine. Sine. Cotang. Tang.		
73 Degrees.			72 Degrees.		

18 Degrees.				19 Degrees.			
Sine.	Cosine.	Tang.	Cotang.	Sine.	Cosine.	Tang.	Cot.
0 9.489982	9.978206	9.511776	10.488224	9.512642	9.975670	9.536972	10.4
1 490371	978165	512206	487794	513009	975627	537382	4
2 490759	978124	512635	487365	513375	975583	537792	4
3 491147	978083	513064	486936	513741	975539	538202	4
4 491535	978042	513493	486507	514107	975496	538611	4
5 491922	978001	513921	486079	514472	975452	539020	4
6 492308	977959	514349	485651	514837	975408	539429	4
7 492695	977918	514777	485223	515202	975365	539837	4
8 493081	977877	515204	484796	515566	975321	540245	4
9 493466	977835	515631	484369	515930	975277	540653	4
10 493851	977794	516057	483943	516294	975233	541061	4
11 9.494236	9.977752	9.516484	10.483516	9.516657	9.975189	9.541468	10.4
12 494621	977711	516910	483090	517020	975145	541875	4
13 495005	977669	517335	482665	517382	975101	542281	4
14 495388	977628	517761	482239	517745	975057	542688	4
15 495772	977586	518185	481815	518107	975013	543094	4
16 496154	977544	518610	481390	518468	974969	543499	4
17 496537	977503	519034	480966	518829	974925	543905	4
18 496919	977461	519458	480542	519190	974880	544310	4
19 497301	977419	519882	480118	519551	974836	544715	4
20 497682	977377	520305	479695	519911	974792	545119	4
21 9.498064	9.977335	9.520728	10.479272	9.520271	9.974743	9.545524	10.4
22 498444	977293	521151	478849	520631	974703	545928	4
23 498825	977251	521573	478427	520990	974659	546331	4
24 499204	977209	521995	478005	521349	974614	546735	4
25 499584	977167	522417	477583	521707	974570	547138	4
26 499963	977125	522838	477162	522066	974525	547540	4
27 500342	977083	523259	476741	522424	974481	547943	4
28 500721	977041	523680	476320	522781	974436	548345	4
29 501099	976999	524100	475900	523138	974391	548747	4
30 501476	976957	524520	475480	523495	974347	549149	4
31 9.501854	9.976914	9.524939	10.475061	9.523852	9.974302	9.549550	10.4
32 502231	976872	525359	474641	524208	974257	549951	4
33 502607	976830	525778	474222	524564	974212	550352	4
34 502984	976787	526197	473803	524920	974167	550752	4
35 503360	976745	526615	473385	525275	974122	551152	4
36 503735	976702	527033	472967	525630	974077	551552	4
37 504110	976660	527451	472549	525984	974032	551952	4
38 504485	976617	527868	472132	526339	973987	552351	4
39 504860	976574	528285	471715	526693	973942	552750	4
40 505234	976532	528702	471298	527046	973897	553149	4
41 9.505608	9.976489	9.529119	10.470881	9.527400	9.973852	9.553548	10.4
42 505981	976446	529535	470465	527753	973807	553946	4
43 506354	976404	529950	470050	528105	973761	554344	4
44 506727	976361	530366	469634	528458	973716	554741	4
45 507099	976318	530781	469219	528810	973671	555139	4
46 507471	976275	531196	468804	529161	973625	555536	4
47 507843	976232	531611	468389	529513	973580	555933	4
48 508214	976189	532025	467975	529864	973535	556329	4
49 508585	976146	532439	467561	530215	973489	556725	4
50 508956	976103	532853	467147	530565	973444	557121	4
51 9.509326	9.976060	9.533266	10.466734	9.530915	9.973398	9.557517	10.4
52 509696	976017	533679	466321	531265	973352	557913	4
53 510065	975974	534092	465908	531614	973307	558308	4
54 510434	975930	534504	465496	531963	973261	558702	4
55 510803	975887	534916	465084	532312	973215	559097	4
56 511172	975844	535328	464672	532661	973169	559491	4
57 511540	975800	535739	464261	533009	973124	559885	4
58 511907	975757	536150	463850	533357	973078	560279	4
59 512275	975714	536561	463439	533704	973032	560673	4
60 512642	975670	536972	463028	534052	972986	561066	4
Cosine.	Sine.	Cotang.	Tang.	Cosine.	Sine.	Cotang.	
71 Degrees.				70 Degrees.			

20 Degrees.				21 Degrees.			
Sine.	Cosine.	Tang.	Cotang.	Sine.	Cosine.	Tang.	Cotang.
19. 534082	9.972986	9.561066	10.438934	9.554329	9.970132	9.584177	10.415823
1 534399	972940	561459	438541	554658	970103	584555	415445
2 534745	972894	561851	438149	554987	970055	584932	415068
3 535092	972848	562244	437756	555315	970006	585309	414691
4 535438	972802	562636	437364	555643	969957	585686	414314
5 535783	972755	563028	436972	555971	969909	586062	413938
6 536129	972709	563419	436581	556299	969860	586439	413561
7 536474	972663	563811	436189	556626	969811	586815	413185
8 536818	972617	564202	435798	556953	969762	587190	412810
9 537163	972570	564592	435408	557280	969714	587566	412434
10 537507	972524	564983	435017	557606	969665	587941	412059
11 537851	9.972478	9.565373	10.434627	9.557932	9.969616	9.588316	10.411684
12 538194	972431	565763	434237	558258	969567	588691	411309
13 538538	972385	566153	433847	558583	969518	589066	410934
14 538880	972338	566542	433458	558909	969469	589440	410560
15 539223	972291	566932	433068	559234	969420	589814	410186
16 539565	972245	567320	432680	559558	969370	590188	409812
17 539907	972198	567709	432291	559883	969321	590562	409438
18 540249	972151	568098	431902	560207	969272	590935	409065
19 540590	972105	568486	431514	560531	969223	591308	408692
20 540931	972058	568873	431127	560855	969173	591681	408319
21 541272	9.972011	9.569261	10.430739	9.561178	9.969124	9.592054	10.407946
22 541613	971964	569648	430352	561501	969075	592426	407574
23 541953	971917	570035	429965	561824	969025	592798	407202
24 542293	971870	570422	429578	562146	968976	593171	406829
25 542632	971823	570809	429191	562468	968926	593542	406458
26 542971	971776	571195	428805	562790	968877	593914	406086
27 543310	971729	571581	428419	563112	968827	594285	405715
28 543649	971682	571967	428033	563433	968777	594656	405344
29 543987	971635	572352	427648	563755	968728	595027	404973
30 544325	971588	572738	427262	564075	968678	595398	404602
31 544663	9.971540	9.573123	10.426877	9.564396	9.968628	9.595768	10.404232
32 545000	971493	573507	426493	564716	968578	596138	403862
33 545338	971446	573892	426108	565036	968528	596508	403492
34 545674	971398	574276	425724	565356	968479	596878	403122
35 546011	971351	574660	425340	565676	968429	597247	402753
36 546347	971303	575044	424956	565995	968379	597616	402384
37 546683	971256	575427	424573	566314	968329	597985	402015
38 547019	971208	575810	424190	566632	968278	598354	401646
39 547354	971161	576193	423807	566951	968228	598722	401278
40 547689	971113	576576	423424	567269	968178	599091	400909
41 548024	9.971066	9.576959	10.423041	9.567587	9.968128	9.599459	10.400541
42 548359	971018	577341	422659	567904	968078	599827	400173
43 548693	970970	577723	422277	568222	968027	600194	399806
44 549027	970922	578104	421896	568539	967977	600562	399438
45 549360	970874	578486	421514	568856	967927	600929	399071
46 549693	970827	578867	421133	569172	967876	601296	398704
47 550026	970779	579248	420752	569488	967826	601662	398338
48 550359	970731	579629	420371	569804	967775	602029	397971
49 550692	970683	580009	419991	570120	967725	602395	397605
50 551024	970635	580389	419611	570435	967674	602761	397239
51 551356	9.970586	9.580769	10.419231	9.570751	9.967624	9.603127	10.396873
52 551687	970538	581149	418851	571066	967573	603493	396507
53 552018	970490	581528	418472	571380	967522	603858	396142
54 552349	970442	581907	418093	571695	967471	604223	395777
55 552680	970394	582286	417714	572009	967421	604588	395412
56 553010	970345	582665	417335	572323	967370	604953	395047
57 553341	970297	583043	416957	572636	967319	605317	394683
58 553670	970249	583422	416578	572950	967268	605682	394318
59 554000	970200	583800	416200	573263	967217	606046	393954
60 554329	970152	584177	415823	573575	967166	606410	393590
Cosine.	Sine.	Cotang.	Tang.	Cosine.	Sine.	Cotang.	Tang.
69 Degrees.				68 Degrees.			

22 Degrees.				23 Degrees.			
Sine.	Cosine.	Tang.	Cotang.	Sine.	Cosine.	Tang.	Cotang.
0 9.573575	9.967166	9.606410	10.393590	9.591878	9.964026	9.627852	10.372
1 573888	967115	606773	393227	592176	963972	628203	371
2 574200	967064	607137	392863	592473	963919	628554	371
3 574512	967013	607500	392500	592770	963865	628905	371
4 574824	966961	607863	392137	593067	963811	629255	370
5 575136	966910	608225	391775	593363	963757	629606	370
6 575447	966859	608588	391412	593659	963704	629956	370
7 575758	966808	608950	391050	593955	963650	630306	369
8 576069	966756	609312	390688	594251	963596	630656	369
9 576379	966705	609674	390326	594547	963542	631005	368
10 576689	966653	610036	389964	594842	963488	631355	368
11 576999	966602	610397	389603	595137	963434	631704	368
12 577309	966550	610759	389241	595432	963379	632053	367
13 577618	966499	611120	388880	595727	963325	632401	367
14 577927	966447	611480	388520	596021	963271	632750	367
15 578236	966395	611841	388159	596315	963217	633098	366
16 578545	966344	612201	387799	596609	963163	633447	366
17 578853	966292	612561	387439	596903	963108	633795	366
18 579162	966240	612921	387079	597196	963054	634143	365
19 579470	966188	613281	386719	597490	962999	634490	365
20 579777	966136	613641	386359	597783	962945	634838	365
21 580085	966085	614000	386000	598075	962890	635185	364
22 580392	966033	614359	385641	598368	962836	635532	364
23 580699	965981	614718	385282	598660	962781	635879	364
24 581005	965929	615077	384923	598952	962727	636226	363
25 581312	965876	615435	384565	599244	962672	636572	363
26 581618	965824	615793	384207	599536	962617	636919	363
27 581924	965772	616151	383849	599827	962562	637265	362
28 582229	965720	616509	383491	600118	962508	637611	362
29 582535	965668	616867	383133	600409	962453	637956	362
30 582840	965615	617224	382776	600700	962398	638302	361
31 583145	965563	617582	382418	600990	962343	638647	361
32 583449	965511	617939	382061	601280	962288	638992	361
33 583754	965458	618295	381705	601570	962233	639337	360
34 584058	965406	618652	381348	601860	962178	639682	360
35 584361	965353	619008	380992	602150	962123	640027	359
36 584665	965301	619364	380636	602439	962067	640371	359
37 584968	965248	619721	380279	602728	962012	640716	358
38 585272	965195	620076	379924	603017	961957	641060	358
39 585574	965143	620432	379568	603305	961902	641404	358
40 585877	965090	620787	379213	603594	961846	641747	358
41 586179	965037	621142	378858	603882	961791	642091	357
42 586482	964984	621497	378503	604170	961735	642434	357
43 586783	964931	621852	378148	604457	961680	642777	357
44 587085	964879	622207	377793	604745	961624	643120	356
45 587386	964826	622561	377439	605032	961569	643463	356
46 587688	964773	622915	377085	605319	961513	643806	356
47 587989	964720	623269	376731	605606	961458	644148	355
48 588289	964666	623623	376377	605892	961402	644490	355
49 588590	964613	623976	376024	606179	961346	644832	355
50 588890	964560	624330	375670	606465	961290	645174	354
51 589190	964507	624683	375317	606751	961235	645516	354
52 589489	964454	625036	374964	607036	961179	645857	354
53 589789	964400	625388	374612	607322	961123	646199	353
54 590088	964347	625741	374259	607607	961067	646540	353
55 590387	964294	626093	373907	607892	961011	646881	353
56 590686	964240	626445	373555	608177	960955	647222	352
57 590984	964187	626797	373203	608461	960899	647562	352
58 591282	964133	627149	372851	608745	960843	647903	352
59 591580	964080	627501	372499	609029	960786	648243	351
60 591878	964026	627852	372148	609313	960730	648583	351
Cosine.	Sine.	Cotang.	Tang.	Cosine.	Sine.	Cotang.	Tang.
67 Degrees.				66 Degrees.			

Degrees.		25 Degrees.					
E.	Tang.	Cotang.	Sine.	Cosine.	Tang.	Cotang.	
30	9.648583	10.351417	9.625948	9.957276	9.668673	10.331327	60
74	648923	351077	626219	957217	669002	330998	59
18	649263	350737	626490	957158	669332	330668	58
61	649602	350398	626760	957099	669661	330339	57
95	649942	350058	627030	957040	669991	330009	56
43	650281	349719	627300	956981	670320	329680	55
92	650620	349380	627570	956921	670649	329351	54
35	650959	349041	627840	956862	670977	329023	53
79	651297	348703	628109	956803	671306	328694	52
22	651636	348364	628378	956744	671634	328366	51
65	651974	348026	628647	956684	671963	328037	50
09	9.652312	10.347688	9.628916	9.956625	9.672291	10.327709	49
52	652650	347350	629185	956566	672619	327381	48
95	652988	347012	629453	956506	672947	327053	47
38	653326	346674	629721	956447	673274	326726	46
82	653663	346337	629989	956387	673602	326398	45
25	654000	346000	630257	956327	673929	326071	44
68	654337	345663	630524	956268	674257	325743	43
11	654674	345326	630792	956208	674584	325416	42
54	655011	344989	631059	956148	674910	325090	41
96	655348	344652	631326	956089	675237	324763	40
39	9.655684	10.344316	9.631593	9.956029	9.675564	10.324436	39
82	656020	343980	631859	955969	675890	324410	38
25	656356	343644	632125	955909	676217	323783	37
68	656692	343308	632392	955849	676543	323457	36
10	657028	342972	632658	955789	676869	323131	35
53	657364	342636	632923	955729	677194	322806	34
95	657699	342301	633189	955669	677520	322480	33
138	658034	341966	633454	955609	677846	322154	32
80	658369	341631	633719	955548	678171	321829	31
23	658704	341296	633984	955488	678496	321504	30
65	9.659039	10.340961	9.634249	9.955428	9.678821	10.321179	29
98	659373	340627	634514	955368	679146	320854	28
50	659708	340292	634778	955307	679471	320529	27
792	660042	339958	635042	955247	679795	320205	26
734	660376	339624	635306	955186	680120	319880	25
677	660710	339290	635570	955126	680444	319556	24
619	661043	338957	635834	955065	680768	319232	23
561	661377	338623	636097	955005	681092	318908	22
503	661710	338290	636360	954944	681416	318584	21
445	662043	337957	636623	954883	681740	318260	20
387	9.662376	10.337624	9.636886	9.954823	9.682063	10.317937	19
329	662709	337291	637148	954762	682387	317613	18
271	663042	336958	637411	954701	682710	317290	17
213	663375	336625	637673	954640	683033	316967	16
154	663707	336293	637935	954579	683356	316644	15
996	664039	335961	638197	954518	683679	316321	14
938	664371	335629	638458	954457	684001	315999	13
979	664703	335297	638720	954396	684324	315676	12
921	665035	334965	638981	954335	684646	315354	11
863	665366	334634	639242	954274	684968	315032	10
804	9.665697	10.334303	9.639503	9.954213	9.685290	10.314710	9
746	666029	333971	639764	954152	685612	314388	8
687	666360	333640	640024	954090	685934	314066	7
628	666691	333309	640284	954029	686255	313745	6
570	667021	332979	640544	953968	686577	313423	5
511	667352	332648	640804	953906	686898	313102	4
452	667682	332318	641064	953845	687219	312781	3
393	668013	331987	641324	953783	687540	312460	2
335	668343	331657	641583	953722	687861	312139	1
276	668672	331328	641842	953660	688182	311818	0
Cotang.		Tang.	Cosine.	Sine.	Cotang.	Tang.	
Degrees.		64 Degrees.					

26 Degrees.				27 Degrees.				
Sine.	Cosine.	Tang.	Cotang.	Sine.	Cosine.	Tang.	Cotang.	
0	9.641842	9.953660	9.688182	10.311818	9.657047	9.948881	9.707166	10.292
1	642101	953599	688502	311498	657295	949816	707478	292
2	642360	953537	688823	311177	657542	949752	707790	292
3	642618	953475	689143	310857	657790	949688	708102	291
4	642877	953413	689463	310537	658037	949623	708414	291
5	643135	953352	689783	310217	658284	949558	708726	291
6	643393	953290	690103	309897	658531	949494	709037	290
7	643650	953228	690423	309577	658778	949429	709349	290
8	643908	953166	690742	309258	659025	949364	709660	290
9	644165	953104	691062	308938	659271	949300	709971	290
10	644423	953042	691381	308619	659517	949235	710282	289
11	9.644680	9.952980	9.691700	10.308300	9.659763	9.949170	9.710593	10.288
12	644936	952918	692019	307981	660009	949105	710904	288
13	645193	952855	692338	307662	660255	949040	711215	288
14	645450	952793	692656	307344	660501	948975	711525	288
15	645706	952731	692975	307025	660746	948910	711836	288
16	645962	952669	693293	306707	660991	948845	712146	287
17	646218	952606	693612	306388	661236	948780	712456	287
18	646474	952544	693930	306070	661481	948715	712766	287
19	646729	952481	694248	305752	661726	948650	713076	286
20	646984	952419	694566	305434	661970	948584	713386	286
21	9.647240	9.952356	9.694883	10.305117	9.662214	9.948519	9.713696	10.286
22	647494	952294	695201	304799	662459	948454	714005	285
23	647749	952231	695518	304482	662703	948388	714314	285
24	648004	952168	695836	304164	662946	948323	714624	285
25	648258	952106	696153	303847	663190	948257	714933	285
26	648512	952043	696470	303530	663433	948192	715242	284
27	648766	951980	696787	303213	663677	948126	715551	284
28	649020	951917	697103	302897	663920	948060	715860	284
29	649274	951854	697420	302580	664163	947995	716168	283
30	649527	951791	697736	302264	664406	947929	716477	283
31	9.649781	9.951728	9.698053	10.301947	9.664648	9.947863	9.716785	10.283
32	650034	951665	698369	301631	664891	947797	717093	282
33	650287	951602	698685	301315	665133	947731	717401	282
34	650539	951539	699001	300999	665375	947665	717709	282
35	650792	951476	699316	300684	665617	947600	718017	281
36	651044	951412	699632	300368	665859	947533	718325	281
37	651297	951349	699947	300053	666100	947467	718633	281
38	651549	951286	700263	299737	666342	947401	718940	281
39	651800	951222	700578	299422	666583	947335	719248	280
40	652052	951159	700893	299107	666824	947269	719555	280
41	9.652304	9.951096	9.701208	10.298792	9.667065	9.947203	9.719862	10.280
42	652555	951032	701523	298477	667305	947136	720169	279
43	652806	950968	701837	298163	667546	947070	720476	279
44	653057	950905	702152	297848	667786	947004	720783	279
45	653308	950841	702466	297534	668027	946937	721089	278
46	653558	950778	702780	297220	668267	946871	721396	278
47	653808	950714	703095	296905	668506	946804	721702	278
48	654059	950650	703409	296591	668746	946738	722009	277
49	654309	950586	703723	296277	668986	946671	722315	277
50	654558	950522	704036	295964	669225	946604	722621	277
51	9.654808	9.950458	9.704350	10.295650	9.669464	9.946538	9.722927	10.277
52	655058	950394	704663	295637	669703	946471	722932	276
53	655307	950330	704977	295323	669942	946404	723238	276
54	655556	950266	705290	295010	670181	946337	723544	276
55	655805	950202	705603	294697	670419	946270	723849	275
56	656054	950138	705916	294384	670658	946203	724154	275
57	656302	950074	706228	294072	670896	946136	724459	275
58	656551	950010	706541	293759	671134	946069	724764	274
59	656799	949945	706854	293446	671372	946002	725069	274
60	657047	949881	707166	293134	671609	945935	725374	274
Cosine. Sine. Cotang. Tang.				Cosine. Sine. Cotang. Tang.				
63 Degrees.				62 Degrees.				

28 Degrees.				29 Degrees.			
Sine.	Cosine.	Tang.	Cotang.	Sine.	Cosine.	Tang.	Cotang.
9.671609	9.945935	9.725674	10.274326	9.685571	9.941819	9.743752	10.256248
671647	945868	725979	274021	685799	941749	744050	255950
672084	945800	726284	273716	686027	941679	744348	255652
672321	945733	726538	273412	686254	941609	744645	255355
672558	945666	726892	273108	686482	941539	744943	255057
672795	945598	727197	272803	686709	941469	745240	254760
673032	945531	727501	272499	686936	941398	745538	254462
673268	945464	727805	272195	687163	941328	745835	254165
673505	945396	728109	271891	687389	941258	746132	253868
673741	945328	728412	271588	687616	941187	746429	253571
673977	945261	728716	271284	687843	941117	746726	253274
1 9.674213	9.945193	9.729020	10.270980	9.688069	9.941046	9.747023	10.252977
2 674448	945125	729323	270677	688295	940975	747319	252681
3 674684	945058	729626	270374	688521	940905	747616	252384
4 674919	944990	729929	270071	688747	940834	747913	252087
5 675155	944922	730233	269767	688972	940763	748209	251791
6 675390	944854	730535	269465	689198	940693	748505	251495
7 675624	944786	730838	269162	689423	940622	748801	251199
8 675859	944718	731141	268859	689648	940551	749097	250903
9 676094	944650	731444	268556	689873	940480	749393	250607
10 676328	944582	731746	268254	690098	940409	749689	250311
11 9.676562	9.944514	9.732048	10.267952	9.690323	9.940338	9.749985	10.250015
12 676796	944446	732351	267649	690548	940267	750281	249719
13 677030	944377	732653	267347	690772	940196	750576	249424
14 677264	944309	732955	267045	690996	940125	750872	249128
15 677498	944241	733257	266743	691220	940054	751167	248833
16 677731	944172	733558	266442	691444	939982	751462	248538
17 677964	944104	733860	266140	691668	939911	751757	248243
18 678197	944036	734162	265838	691892	939840	752052	247948
19 678430	943967	734463	265537	692115	939768	752347	247653
20 678663	943899	734764	265236	692339	939697	752642	247358
21 9.678895	9.943830	9.735066	10.264934	9.692562	9.939625	9.752937	10.247063
22 679128	943761	735367	264633	692785	939554	753231	246769
23 679360	943693	735668	264332	693008	939482	753526	246474
24 679592	943624	735969	264031	693231	939410	753820	246180
25 679824	943555	736269	263731	693453	939339	754115	245885
26 680056	943486	736570	263430	693676	939267	754409	245591
27 680288	943417	736871	263129	693898	939195	754703	245297
28 680519	943348	737171	262829	694120	939123	754997	245003
29 680750	943279	737471	262529	694342	939052	755291	244709
30 680982	943210	737771	262229	694564	938980	755585	244415
31 9.681213	9.943141	9.738071	10.261929	9.694786	9.938908	9.755878	10.244122
32 681443	943072	738371	261629	695007	938836	756172	243828
33 681674	943003	738671	261329	695229	938763	756465	243535
34 681905	942934	738971	261029	695450	938691	756759	243241
35 682135	942864	739271	260729	695671	938619	757052	242948
36 682365	942795	739570	260430	695892	938547	757345	242655
37 682595	942726	739870	260130	696113	938475	757638	242362
38 682825	942656	740169	259831	696334	938402	757931	242069
39 683055	942587	740468	259532	696554	938330	758224	241776
40 683284	942517	740767	259233	696775	938258	758517	241483
41 9.683514	9.942448	9.741066	10.258934	9.696995	9.938185	9.758810	10.241190
42 683743	942378	741365	258635	697215	938113	759102	240898
43 683972	942308	741664	258336	697435	938040	759395	240605
44 684201	942239	741962	258038	697654	937967	759687	240313
45 684430	942169	742261	257739	697874	937895	759979	240021
46 684658	942099	742559	257441	698094	937822	760272	239728
47 684887	942029	742858	257142	698313	937749	760564	239436
48 685115	941959	743156	256844	698532	937676	760856	239144
49 685343	941889	743454	256546	698751	937604	761148	238852
50 685571	941819	743752	256248	698970	937531	761439	238559
Cosine.	Sine.	Cotang.	Tang.	Cosine.	Sine.	Cotang.	Tang.
61 Degrees.				60 Degrees.			

30 Degrees.				31 Degrees.			
Sine.	Cosine.	Tang.	Cotang.	Sine.	Cosine.	Tang.	Cotang.
0 9.698970	9.937531	9.761439	10.238561	9.711839	9.933066	9.778774	10.221226
1 699189	937458	761731	238269	712050	932990	779060	221940
2 699407	937385	762023	237977	712260	932914	779346	221654
3 699626	937312	762314	237686	712469	932838	779632	221368
4 699844	937238	762606	237394	712679	932762	779918	221082
5 700062	937165	762897	237103	712889	932685	780203	220796
6 700280	937092	763188	236812	713098	932609	780489	220510
7 700498	937019	763479	236521	713308	932533	780775	220224
8 700716	936946	763770	236230	713517	932457	781060	219938
9 700933	936872	764061	235939	713726	932380	781346	219652
10 701151	936799	764352	235648	713935	932304	781631	219366
11 701368	936725	764643	10.235357	9.714144	9.932228	9.781916	10.218774
12 701585	936652	764933	235067	714352	932151	782201	219080
13 701802	936578	765224	234776	714561	932075	782486	218794
14 702019	936505	765514	234486	714769	931998	782771	218508
15 702236	936431	765805	234195	714978	931921	783056	218222
16 702452	936357	766095	233905	715186	931845	783341	217936
17 702669	936284	766385	233615	715394	931768	783626	217650
18 702885	936210	766675	233325	715602	931691	783910	217364
19 703101	936136	766965	233035	715809	931614	784195	217078
20 703317	936062	767255	232745	716017	931537	784479	216792
21 703533	935988	767545	10.232455	9.716224	9.931460	9.784764	10.216900
22 703749	935914	767834	232166	716432	931383	785048	216504
23 703964	935840	768124	231876	716639	931306	785332	216218
24 704179	935766	768414	231586	716846	931229	785616	215932
25 704395	935692	768703	231297	717053	931152	785900	215646
26 704610	935618	768992	231008	717259	931075	786184	215360
27 704825	935543	769281	230719	717466	930998	786468	215074
28 705040	935469	769570	230430	717673	930921	786752	214788
29 705254	935395	769860	230140	717879	930843	787036	214502
30 705469	935320	770148	229852	718085	930766	787319	214216
31 9.705683	9.935246	9.770437	10.229563	9.718291	9.930688	9.787603	10.213774
32 705888	935171	770726	229274	718497	930611	787886	213930
33 706112	935097	771015	228985	718703	930533	788170	213644
34 706326	935022	771303	228697	718909	930456	788453	213358
35 706539	934948	771592	228408	719114	930378	788736	213072
36 706753	934873	771880	228120	719320	930300	789019	212786
37 706967	934798	772168	227832	719525	930223	789302	212500
38 707180	934723	772457	227543	719730	930145	789585	212214
39 707393	934648	772745	227255	719935	930067	789868	211928
40 707606	934574	773033	226967	720140	929989	790151	211642
41 9.707819	9.934499	9.773321	10.226679	9.720345	9.929911	9.790433	10.213774
42 708032	934424	773608	226392	720549	929833	790716	211356
43 708245	934349	773896	226104	720754	929755	790999	211070
44 708458	934274	774184	225816	720958	929677	791281	210784
45 708670	934199	774471	225529	721162	929599	791563	210498
46 708882	934123	774759	225241	721366	929521	791846	210212
47 709094	934048	775046	224954	721570	929442	792128	209926
48 709306	933973	775333	224667	721774	929364	792410	209640
49 709518	933898	775621	224379	721978	929286	792692	209354
50 709730	933822	775908	224092	722181	929207	792974	209068
51 9.709941	9.933747	9.776195	10.223805	9.722385	9.929129	9.793256	10.213774
52 710153	933671	776482	223518	722588	929050	793538	208782
53 710364	933596	776769	223231	722791	928972	793819	208496
54 710575	933520	777055	222945	722994	928893	794101	208210
55 710786	933445	777342	222658	723197	928815	794383	207924
56 710997	933369	777628	222372	723400	928736	794664	207638
57 711208	933293	777915	222085	723603	928657	794945	207352
58 711419	933217	778201	221799	723805	928578	795227	207066
59 711629	933141	778487	221513	724007	928499	795508	206780
60 711839	933066	778774	221226	724210	928420	795788	206494
Cosine.	Sine.	Cotang.	Tang.	Cosine.	Sine.	Cotang.	Tang.
59 Degrees.				58 Degrees.			

32 Degrees.				33 Degrees.			
Sine.	Cosine.	Tang.	Cotang.	Sine.	Cosine.	Tang.	Cotang.
19. 724210	9.928420	9.795789	10.204211	9.736109	9.923591	9.812517	10.187483
724412	928342	796070	203930	736303	923509	812794	187206
724614	928263	796351	203649	736498	923427	813070	186930
724816	928183	796632	203368	736692	923345	813347	186653
725017	928104	796913	203087	736886	923263	813623	186377
725219	928025	797194	202806	737080	923181	813899	186101
725420	927946	797475	202525	737274	923098	814175	185825
725622	927867	797755	202245	737467	923016	814452	185548
725823	927787	798036	201964	737661	922933	814728	185272
726024	927708	798316	201684	737855	922851	815004	184996
726225	927629	798596	201404	738048	922768	815279	184721
19. 726426	9.927549	9.798877	10.201123	9.738241	9.922686	9.815555	10.184445
726626	927470	799157	200843	738434	922603	815831	184469
726827	927390	799437	200563	738627	922520	816107	183993
727027	927310	799717	200283	738820	922438	816382	183618
727228	927231	799997	200003	739013	922355	816658	183242
727428	927151	800277	199723	739206	922272	816933	182867
727628	927071	800557	199443	739398	922189	817209	182491
727828	926991	800836	199164	739590	922106	817484	182116
728027	926911	801116	198884	739783	922023	817759	181741
728227	926831	801396	198604	739975	921940	818035	181365
21. 728427	9.926751	9.801675	10.198325	9.740167	9.921857	9.818310	10.181690
728626	926671	801955	198045	740359	921774	818585	181415
728825	926591	802234	197766	740550	921691	818860	181140
729024	926511	802513	197487	740742	921607	819135	180865
729223	926431	802792	197208	740934	921524	819410	180590
729422	926351	803072	196928	741125	921441	819684	180316
729621	926270	803351	196649	741316	921357	819959	180041
729820	926190	803630	196370	741508	921274	820234	179766
730018	926110	803908	196092	741699	921190	820508	179492
730217	926029	804187	195813	741889	921107	820783	179217
31. 730415	9.925949	9.804466	10.195534	9.742080	9.921023	9.821057	10.178943
730613	925868	804745	195255	742271	920939	821332	178668
730811	925788	805023	194977	742462	920856	821606	178394
731009	925707	805302	194698	742652	920772	821880	178120
731206	925626	805580	194420	742842	920688	822154	177846
731404	925545	805859	194141	743033	920604	822429	177571
731602	925465	806137	193863	743223	920520	822703	177297
731799	925384	806415	193585	743413	920436	822977	177023
731996	925303	806693	193307	743602	920352	823250	176750
732193	925222	806971	193029	743792	920268	823524	176476
41. 732390	9.925141	9.807249	10.192751	9.743982	9.920184	9.823798	10.176202
732587	925060	807527	192473	744171	920099	824072	175928
732784	924979	807805	192195	744361	920015	824345	175655
732980	924897	808083	191917	744550	919931	824619	175381
733177	924816	808361	191639	744739	919846	824893	175107
733373	924735	808638	191362	744928	919762	825166	174834
733569	924654	808916	191084	745117	919677	825439	174561
733765	924572	809193	190807	745306	919593	825713	174287
733961	924491	809471	190529	745494	919508	825986	174014
734157	924409	809748	190252	745683	919424	826259	173741
51. 734353	9.924328	9.810025	10.189975	9.745871	9.919339	9.826532	10.173468
734549	924246	810302	189698	746060	919254	826805	173495
734744	924164	810580	189420	746248	919169	827078	173222
734939	924083	810857	189143	746436	919085	827351	172949
735135	924001	811134	188866	746624	919000	827624	172676
735330	923919	811410	188590	746812	918915	827897	172403
735525	923837	811687	188313	746999	918830	828170	172130
735719	923755	811964	188036	747187	918745	828442	171858
735914	923673	812241	187759	747374	918659	828715	171585
736109	923591	812517	187483	747562	918574	828987	171313
Cosine.	Sine.	Cotang.	Tang.	Cosine.	Sine.	Cotang.	Tang.
57 Degrees.				56 Degrees.			

34 Degrees.				35 Degrees.			
Sine.	Cosine.	Tang.	Cotang.	Sine.	Cosine.	Tang.	Cot.
0 9.747562	9.918574	9.828987	10.171013	9.758591	9.913365	9.845227	10.1
1 747749	918489	829260	170740	758772	913276	845496	1
2 747936	918404	829532	170468	758952	913187	845764	1
3 748123	918318	829805	170195	759132	913099	846033	1
4 748310	918233	830077	169923	759312	913010	846302	1
5 748497	918147	830349	169651	759492	912922	846570	1
6 748683	918062	830621	169379	759672	912833	846839	1
7 748870	917976	830893	169107	759852	912744	847107	1
8 749056	917891	831165	168835	760031	912655	847376	1
9 749243	917805	831437	168563	760211	912566	847644	1
10 749429	917719	831709	168291	760390	912477	847913	1
11 749615	9.917634	9.831981	10.169019	9.760569	9.912388	9.848181	10.1
12 749801	917548	832253	167747	760748	912299	848449	1
13 749987	917462	832525	167475	760927	912210	848717	1
14 750172	917376	832796	167204	761106	912121	848986	1
15 750358	917290	833068	166932	761285	912031	849254	1
16 750543	917204	833339	166661	761464	911942	849522	1
17 750729	917118	833611	166389	761642	911853	849790	1
18 750914	917032	833882	166118	761821	911763	850058	1
19 751099	916946	834154	165846	761999	911674	850325	1
20 751284	916859	834425	165575	762177	911584	850593	1
21 751469	9.916773	9.834696	10.165304	9.762356	9.911495	9.850861	10.1
22 751654	916687	834967	165303	762534	911405	851129	1
23 751839	916600	835238	164762	762712	911315	851396	1
24 752023	916514	835509	164491	762890	911226	851664	1
25 752208	916427	835780	164220	763067	911136	851931	1
26 752392	916341	836051	163949	763245	911046	852199	1
27 752576	916254	836322	163678	763422	910956	852466	1
28 752760	916167	836593	163407	763600	910866	852733	1
29 752944	916081	836864	163136	763777	910776	853001	1
30 753128	915994	837134	162866	763954	910686	853268	1
31 753312	9.915907	9.837405	10.162595	9.764131	9.910596	9.853535	10.1
32 753495	915820	837675	162325	764308	910506	853802	1
33 753679	915733	837946	162054	764485	910415	854069	1
34 753862	915646	838216	161784	764662	910325	854336	1
35 754046	915559	838487	161513	764838	910235	854603	1
36 754229	915472	838757	161243	765015	910144	854870	1
37 754412	915385	839027	160973	765191	910054	855137	1
38 754595	915297	839297	160703	765367	909963	855404	1
39 754778	915210	839568	160432	765544	909873	855671	1
40 754960	915123	839838	160162	765720	909782	855938	1
41 755143	9.915035	9.840108	10.159892	9.765896	9.909691	9.856204	10.1
42 755326	914948	840378	159622	766072	909601	856471	1
43 755508	914860	840647	159353	766247	909510	856737	1
44 755690	914773	840917	159083	766423	909419	857004	1
45 755872	914685	841187	158813	766598	909328	857270	1
46 756054	914598	841457	158543	766774	909237	857537	1
47 756236	914510	841726	158274	766949	909146	857803	1
48 756418	914422	841996	158004	767124	909055	858069	1
49 756600	914334	842266	157734	767300	908964	858336	1
50 756782	914246	842535	157465	767475	908873	858602	1
51 756963	9.914158	9.842805	10.157195	9.767649	9.908761	9.858868	10.1
52 757144	914070	843074	156926	767824	908690	859134	1
53 757326	913982	843343	156657	767999	908599	859400	1
54 757507	913894	843612	156388	768173	908507	859666	1
55 757688	913806	843882	156118	768348	908416	859932	1
56 757869	913718	844151	155849	768522	908324	860198	1
57 758050	913630	844420	155580	768697	908233	860464	1
58 758230	913541	844689	155311	768871	908141	860730	1
59 758411	913453	844958	155042	769045	908049	860995	1
60 758591	913365	845227	154773	769219	907958	861261	1
Cosine.	Sine.	Cotang.	Tang.	Cosine.	Sine.	Cotang.	Tang.
55 Degrees.				54 Degrees.			

36 Degrees.				37 Degrees.			
Sine.	Cosine.	Tang.	Cotang.	Sine.	Cosine.	Tang.	Cotang.
0.9. 776219	9.907958	9.861261	10.138739	9.779463	9.902349	9.877114	10.122886
1 776393	9.907866	861527	138473	779631	9.902353	877377	122623
2 776566	9.907774	861792	138208	779798	9.902158	877640	122360
3 776740	9.907682	862058	137942	779966	9.902063	877903	122097
4 776913	9.907590	862323	137677	780133	9.901967	878165	121835
5 777087	9.907498	862589	137411	780300	9.901872	878428	121572
6 777260	9.907406	862854	137146	780467	9.901776	878691	121309
7 777433	9.907314	863119	136881	780634	9.901681	878953	121047
8 777606	9.907222	863385	136615	780801	9.901585	879216	120784
9 777779	9.907129	863650	136350	780968	9.901490	879478	120522
10 777952	9.907037	863915	136085	781134	9.901394	879741	120259
11 9. 771125	9.906945	9.864180	10.135820	9.781301	9.901298	9.880003	10.119997
12 771298	9.906852	864445	135555	781468	9.901202	880265	119735
13 771470	9.906760	864710	135290	781634	9.901106	880528	119472
14 771643	9.906667	864975	135025	781800	9.901010	880790	119210
15 771815	9.906575	865240	134760	781966	9.900914	881052	118948
16 771987	9.906482	865505	134495	782132	9.900818	881314	118686
17 772159	9.906389	865770	134230	782298	9.900722	881576	118424
18 772331	9.906296	866035	133965	782464	9.900626	881839	118161
19 772503	9.906204	866300	133700	782630	9.900529	882101	117899
20 772675	9.906111	866564	133436	782796	9.900433	882363	117637
21 9. 772847	9.906018	9.866829	10.133171	9.782961	9.900337	9.882625	10.117375
22 773018	9.905925	867094	132906	783127	9.900240	882687	117113
23 773190	9.905832	867358	132642	783292	9.900144	883148	116852
24 773361	9.905739	867623	132377	783458	9.900047	883410	116590
25 773533	9.905645	867887	132113	783623	899951	883672	116328
26 773704	9.905552	868152	131848	783788	899854	883934	116066
27 773875	9.905459	868416	131584	783953	899757	884196	115804
28 774046	9.905366	868680	131320	784118	899660	884457	115543
29 774217	9.905272	868945	131055	784282	899564	884719	115281
30 774388	9.905179	869209	130791	784447	899467	884980	115020
31 9. 774558	9.905085	9.869473	10.130527	9.784612	9.899370	9.885242	10.114758
32 774729	9.904992	869737	130263	784776	899273	885503	114497
33 774899	9.904898	870001	129999	784941	899176	885765	114235
34 775070	9.904804	870265	129735	785105	899078	886026	113974
35 775240	9.904711	870529	129471	785269	898981	886288	113712
36 775410	9.904617	870793	129207	785433	898884	886549	113451
37 775580	9.904523	871057	128943	785597	898787	886810	113190
38 775750	9.904429	871321	128679	785761	898689	887072	112928
39 775920	9.904335	871585	128415	785925	898592	887333	112667
40 776090	9.904241	871849	128151	786089	898494	887594	112406
41 9. 776259	9.904147	9.872112	10.127888	9.786252	9.898397	9.887855	10.112145
42 776429	9.904053	872376	127624	786416	898299	888116	111884
43 776598	9.903959	872640	127360	786579	898202	888377	111623
44 776768	9.903864	872903	127097	786742	898104	888639	111361
45 776937	9.903770	873167	126833	786906	898006	888900	111100
46 777106	9.903676	873430	126570	787069	897908	889160	110838
47 777275	9.903581	873694	126306	787232	897810	889421	110579
48 777444	9.903487	873957	126043	787395	897712	889682	110318
49 777613	9.903392	874220	125780	787557	897614	889943	110057
50 777781	9.903298	874484	125516	787720	897516	890204	109796
51 9. 777950	9.903203	9.874747	10.125253	9.787883	9.897418	9.890465	10.109535
52 778119	9.903108	875010	124990	788045	897320	890725	109275
53 778287	9.903014	875273	124727	788208	897222	890986	109014
54 778455	9.902919	875536	124464	788370	897123	891247	108753
55 778624	9.902824	875800	124200	788532	897025	891507	108493
56 778792	9.902729	876063	123937	788694	896926	891768	108232
57 778960	9.902634	876326	123674	788856	896828	892028	107972
58 779128	9.902539	876589	123411	789018	896729	892289	107711
59 779295	9.902444	876851	123149	789180	896631	892549	107451
60 779463	9.902349	877114	122886	789342	896532	892810	107190
Cosine.	Sine.	Cotang.	Tang.	Cosine.	Sine.	Cotang.	Tang.
53 Degrees.				52 Degrees.			

22 Degrees.				23 Degrees.			
Sine.	Cosine.	Tang.	Cotang.	Sine.	Cosine.	Tang.	Cot.
0 9.573575	9.967166	9.606410	10.393590	9.591878	9.964026	9.627852	10.372148
1 573888	967115	606773	393227	592176	963972	628203	371797
2 574200	967064	607137	392063	592473	963919	628554	371546
3 574512	967013	607500	392500	592770	963865	628905	371295
4 574824	966961	607863	392137	593067	963811	629255	371044
5 575136	966910	608225	391775	593363	963757	629606	370793
6 575447	966859	608588	391412	593659	963704	629956	370542
7 575758	966808	608950	391050	593955	963650	630306	370291
8 576069	966756	609312	390688	594251	963596	630656	370040
9 576379	966705	609674	390326	594547	963542	631005	369789
10 576689	966653	610036	389964	594842	963488	631355	369538
11 576999	966602	610397	10.389603	9.595137	9.963434	9.631704	10.369096
12 577309	966550	610759	389241	595432	963379	632053	369287
13 577618	966499	611120	388880	595727	963325	632401	369036
14 577927	966447	611480	388520	596021	963271	632750	368785
15 578236	966395	611841	388159	596315	963217	633098	368534
16 578545	966344	612201	387799	596609	963163	633447	368283
17 578853	966292	612561	387439	596903	963108	633795	368032
18 579162	966240	612921	387079	597196	963054	634143	367781
19 579470	966188	613281	386719	597490	962999	634490	367530
20 579777	966136	613641	386359	597783	962945	634838	367279
21 9.580085	9.966085	9.614000	10.386000	9.598075	9.962890	9.635185	10.366096
22 580392	966033	614359	385641	598368	962836	635532	367028
23 580699	965981	614718	385282	598660	962781	635879	366777
24 581005	965929	615077	384923	598952	962727	636226	366526
25 581312	965876	615435	384565	599244	962672	636572	366275
26 581618	965824	615793	384207	599536	962617	636919	366024
27 581924	965772	616151	383849	599827	962562	637265	365773
28 582229	965720	616509	383491	600118	962508	637611	365522
29 582535	965668	616867	383133	600409	962453	637956	365271
30 582840	965615	617224	382776	600700	962398	638302	365020
31 9.583145	9.965563	9.617582	10.382418	9.600990	9.962343	9.638647	10.363096
32 583449	965511	617589	382061	601280	962288	638692	364769
33 583754	965458	618295	381705	601570	962233	639337	364518
34 584058	965406	618652	381348	601860	962178	639682	364267
35 584361	965353	619008	380992	602150	962123	640027	364016
36 584665	965301	619364	380636	602439	962067	640371	363765
37 584968	965248	619721	380279	602728	962012	640716	363514
38 585272	965195	620076	379924	603017	961957	641060	363263
39 585574	965143	620432	379568	603305	961902	641404	363012
40 585877	965090	620787	379213	603594	961846	641747	362761
41 9.586179	9.965037	9.621142	10.378858	9.603882	9.961791	9.642091	10.360096
42 586482	964984	621497	378503	604170	961735	642434	362510
43 586783	964931	621852	378148	604457	961680	642777	362259
44 587085	964879	622207	377793	604745	961624	643120	362008
45 587386	964826	622561	377439	605032	961569	643463	361757
46 587688	964773	622915	377085	605319	961513	643806	361506
47 587989	964720	623269	376731	605606	961458	644148	361255
48 588289	964666	623623	376377	605892	961402	644490	361004
49 588590	964613	623976	376024	606179	961346	644832	360753
50 588890	964560	624330	375670	606465	961290	645174	360502
51 9.589190	9.964507	9.624683	10.375317	9.606751	9.961235	9.645516	10.358096
52 589489	964454	625036	374964	607036	961179	645857	360251
53 589789	964400	625388	374612	607322	961123	646199	360000
54 590088	964347	625741	374259	607607	961067	646540	359749
55 590387	964294	626093	373907	607892	961011	646881	359498
56 590686	964240	626445	373555	608177	960955	647222	359247
57 590984	964187	626797	373203	608461	960899	647562	358996
58 591282	964133	627149	372851	608745	960843	647903	358745
59 591580	964080	627501	372499	609029	960786	648243	358494
60 591878	964026	627852	372148	609313	960730	648583	358243
Cosine.	Sine.	Cotang.	Tang.	Cosine.	Sine.	Cotang.	

67 Degrees.

66 Degrees.

40 Degrees.				41 Degrees.			
Sine.	Cosine.	Tang.	Cotang.	Sine.	Cosine.	Tang.	Cotang.
0.980067	9.884254	9.923813	10.076187	9.816943	9.877780	9.939163	10.060837
1.000218	884148	924070	075930	817088	877670	939418	060582
2.000368	884042	924327	075673	817233	877560	939673	060327
3.000519	883936	924583	075417	817379	877450	939928	060072
4.000669	883829	924840	075160	817524	877340	940183	059817
5.000819	883723	925096	074904	817668	877230	940438	059562
6.000969	883617	925352	074648	817813	877120	940694	059306
7.001119	883510	925609	074391	817958	877010	940949	059051
8.001269	883404	925865	074135	818103	876899	941204	058796
9.001419	883297	926122	073878	818247	876789	941458	058542
10.001569	883191	926378	073622	818392	876678	941714	058286
11.001718	883084	9.926634	10.073366	8.818536	8.876568	9.941968	10.058032
12.001868	882977	926890	073110	818681	876457	942223	057777
13.002017	882871	927147	072853	818825	876347	942478	057522
14.002167	882764	927403	072597	818969	876236	942733	057267
15.002316	882657	927659	072341	819113	876125	942988	057012
16.002465	882550	927915	072085	819257	876014	943243	056757
17.002614	882443	928171	071829	819401	875904	943498	056502
18.002763	882336	928427	071573	819545	875793	943752	056248
19.002912	882229	928683	071317	819689	875682	944007	055993
20.003061	882121	928940	071060	819832	875571	944262	055738
21.003210	882014	9.929196	10.070804	8.819976	8.875459	9.944517	10.055483
22.003358	881907	929452	070548	820120	875348	944771	055229
23.003507	881799	929708	070292	820263	875237	945026	054974
24.003655	881692	929964	070036	820406	875126	945281	054719
25.003804	881584	930220	069780	820550	875014	945535	054465
26.003952	881477	930475	069525	820693	874903	945790	054210
27.004101	881369	930731	069269	820836	874791	946045	053955
28.004249	881261	930987	069013	820979	874680	946299	053701
29.004398	881153	931243	068757	821122	874568	946554	053446
30.004546	881046	931499	068501	821265	874456	946808	053192
31.004695	880938	9.931755	10.068245	8.821407	8.874344	9.947063	10.052937
32.004843	880830	932010	067990	821550	874232	947318	052682
33.004991	880722	932266	067734	821693	874121	947572	052428
34.005139	880613	932522	067478	821835	874009	947826	052174
35.005287	880505	932778	067222	821977	873896	948081	051919
36.005435	880397	933033	066967	822120	873784	948336	051664
37.005583	880289	933289	066711	822262	873672	948590	051410
38.005731	880180	933545	066455	822404	873560	948844	051156
39.005879	880072	933800	066200	822546	873448	949099	050901
40.006027	879963	934056	065944	822688	873335	949353	050647
41.006175	879855	9.934311	10.065689	8.822830	8.873223	9.949607	10.050393
42.006323	879746	934567	065433	822972	873110	949862	050138
43.006471	879637	934823	065177	823114	872998	950116	049884
44.006619	879529	935078	064922	823255	872885	950370	049630
45.006767	879420	935333	064667	823397	872772	950625	049375
46.006915	879311	935589	064411	823539	872659	950879	049121
47.007063	879202	935844	064156	823680	872547	951133	048867
48.007211	879093	936100	063900	823821	872434	951388	048612
49.007359	878984	936355	063645	823963	872321	951642	048358
50.007507	878875	936610	063390	824104	872208	951896	048104
51.007655	878766	9.936866	10.063134	8.824245	8.872095	9.952150	10.047850
52.007803	878656	937121	062879	824386	871981	952405	047595
53.007951	878547	937376	062624	824527	871868	952659	047341
54.008099	878438	937632	062368	824668	871755	952913	047087
55.008247	878328	937887	062113	824808	871641	953167	046833
56.008395	878219	938142	061858	824949	871528	953421	046579
57.008543	878109	938398	061602	825090	871414	953675	046325
58.008691	877999	938653	061347	825230	871301	953929	046071
59.008839	877890	938908	061092	825371	871187	954183	045817
60.008987	877780	939163	060837	825511	871073	954437	045563
Cotang.	Cosine.	Sine.	Cotang.	Tang.	Cosine.	Sine.	Cotang.
49 Degrees.				48 Degrees.			

42 Degrees.					43 Degrees.				
Sine.	Cosine.	Tang.	Cotang.		Sine.	Cosine.	Tang.	Cotang.	
0	9.825511	9.871073	9.954437	10.045563	9.833783	9.864127	9.969656	10.0	
1	825651	870960	954691	045309	833919	864010	969909	0	
2	825791	870846	954945	045055	834054	863892	970162	0	
3	825931	870732	955200	044800	834189	863774	970416	0	
4	826071	870618	955454	044546	834325	863656	970669	0	
5	826211	870504	955707	044293	834460	863538	970922	0	
6	826351	870390	955961	044039	834595	863419	971175	0	
7	826491	870276	956215	043785	834730	863301	971429	0	
8	826631	870161	956469	043531	834865	863183	971682	0	
9	826770	870047	956723	043277	834999	863064	971935	0	
10	826910	869933	956977	043023	835134	862946	972188	0	
11	827049	869818	957231	10.042769	835269	862827	972441	10.0	
12	827189	869704	957485	042515	835403	862709	972694	0	
13	827328	869589	957739	042261	835538	862590	972948	0	
14	827467	869474	957993	042007	835672	862471	973201	0	
15	827606	869360	958246	041754	835807	862353	973454	0	
16	827745	869245	958500	041500	835941	862234	973707	0	
17	827884	869130	958754	041246	836075	862115	973960	0	
18	828023	869015	959008	040992	836209	861996	974213	0	
19	828162	868900	959262	040738	836343	861877	974466	0	
20	828301	868785	959516	040484	836477	861758	974719	0	
21	828439	868670	959769	10.040231	836611	861638	974973	10.0	
22	828578	868555	960023	039977	836745	861519	975226	0	
23	828716	868440	960277	039723	836878	861400	975479	0	
24	828855	868324	960531	039469	837012	861280	975732	0	
25	828993	868209	960784	039216	837146	861161	975985	0	
26	829131	868093	961038	038962	837279	861041	976238	0	
27	829269	867978	961291	038709	837412	860922	976491	0	
28	829407	867862	961545	038455	837546	860802	976744	0	
29	829545	867747	961799	038201	837679	860682	976997	0	
30	829683	867631	962052	037948	837812	860562	977250	0	
31	829821	867515	962306	10.037694	837945	860442	977503	10.0	
32	829959	867399	962560	037440	838078	860322	977756	0	
33	830097	867283	962813	037187	838211	860202	978009	0	
34	830234	867167	963067	036933	838344	860082	978262	0	
35	830372	867051	963320	036680	838477	859962	978515	0	
36	830509	866935	963574	036426	838610	859842	978768	0	
37	830646	866819	963827	036173	838742	859721	979021	0	
38	830784	866703	964081	035919	838875	859601	979274	0	
39	830921	866586	964335	035665	839007	859480	979527	0	
40	831058	866470	964588	035412	839140	859360	979780	0	
41	831195	866353	964842	10.035158	839272	859239	979803	10.0	
42	831332	866237	965095	034905	839404	859119	980286	0	
43	831469	866120	965349	034651	839536	858998	980538	0	
44	831606	866004	965602	034398	839668	858877	980791	0	
45	831742	865887	965855	034145	839800	858756	981044	0	
46	831879	865770	966109	033891	839932	858635	981297	0	
47	832015	865653	966362	033638	840064	858514	981550	0	
48	832152	865536	966616	033384	840196	858393	981803	0	
49	832288	865419	966869	033131	840328	858272	982056	0	
50	832425	865302	967123	032877	840459	858151	982309	0	
51	832561	865185	967376	10.032624	840591	858029	982562	10.0	
52	832697	865068	967629	032371	840722	857908	982814	0	
53	832833	864950	967883	032117	840854	857786	983067	0	
54	832969	864833	968136	031864	840985	857665	983320	0	
55	833105	864716	968389	031611	841116	857543	983573	0	
56	833241	864598	968643	031357	841247	857422	983826	0	
57	833377	864481	968896	031104	841378	857300	984079	0	
58	833512	864363	969149	030851	841509	857178	984331	0	
59	833648	864245	969403	030597	841640	857056	984584	0	
60	833783	864127	969656	030344	841771	856934	984837	0	
Cosine.	Sine.	Cotang.	Tang.		Cosine.	Sine.	Cotang.		
47 Degrees.					46 Degrees.				

44 Degrees.				
Sine.	Cosine.	Tang.	Cotang.	'
41771	9.856934	9.984137	10.015163	60
41902	856812	985090	014910	59
42033	856690	985343	014657	58
42163	856568	985596	014404	57
42294	856446	985848	014152	56
42424	856323	986101	013899	55
42555	856201	986354	013646	54
42685	856078	986607	013393	53
42815	855956	986860	013140	52
42946	855833	987112	012888	51
43076	855711	987365	012635	50
43206	9.855588	9.987618	10.012382	49
43336	855465	987871	012129	48
43466	855342	988123	011877	47
43595	855219	988376	011624	46
43725	855096	988629	011371	45
43855	854973	988882	011118	44
43984	854850	989134	010866	43
44114	854727	989387	010613	42
44243	854603	989640	010360	41
44372	854480	989893	010107	40
44502	9.854356	9.990145	10.009855	39
44631	854233	990398	009602	38
44760	864109	990651	009349	37
44889	853986	990903	009097	36
45018	853862	991156	008844	35
45147	853738	991409	008591	34
45276	853614	991662	008338	33
45405	853490	991914	008086	32
45533	853366	992167	007833	31
45662	853242	992420	007580	30
45790	9.853118	9.992672	10.007328	29
45919	852994	992925	007075	28
46047	852869	993178	006822	27
46175	852745	993430	006570	26
46304	852620	993683	006317	25
46432	852496	993936	006064	24
46560	852371	994189	005811	23
46688	852247	994441	005559	22
46816	852122	994694	005306	21
46944	851997	994947	005053	20
47071	9.851872	9.995199	10.004801	19
47199	851747	995452	004548	18
47327	851622	995705	004295	17
47454	851497	995957	004043	16
47582	851372	996210	003790	15
47709	851246	996463	003537	14
47836	851121	996715	003285	13
47964	850996	996968	003032	12
48091	850870	997221	002779	11
48218	850745	997473	002527	10
48345	9.850619	9.997726	10.002274	9
48472	850493	997979	002021	8
48599	850368	998231	001769	7
48726	850242	998484	001516	6
48852	850116	998737	001263	5
48979	849990	998989	001011	4
49106	849864	999242	000758	3
49232	849738	999495	000505	2
49359	849611	999747	000253	1
49485	849485	10.00000	000000	0
45 Degrees.				
Sine.	Cotang.	Tang.		

RULES FOR FINDING LOGARITHMIC SECANTS, VERSED SINES, &c.

- I. To find the Secant.—Subtract the Log. Cosine from 20.
- II. To find the Coscant.—Subtract the Log. Sine from 20.
- III. To find the Versed Sine.—Add 0.301030 to twice the Log. Sine of half the arc, and diminish the index of the sum by 10.
- IV. To find the Covered Sine.—Add 0.301030 to twice the Log. Sine of half the complement of the arc, and diminish the index of the sum by 10.

RULES FOR FINDING NATURAL SECANTS, VERSED SINES, &c.

- I. To find the Secant.—Divide 1 by the Natural Cosine.
 - II. To find the Coscant.—Divide 1 by the Natural Sine.
 - III. To find the Versed Sine.—Subtract the Natural Cosine from 1.
 - IV. To find the Covered Sine.—Subtract the Natural Sine from 1.
- In France the circumference of the circle has lately been divided into 400 degrees, the degree into 100 minutes, and the minute into 100 seconds, which is called the centesimal division, and is to the sexagesimal in the ratio of 9 to 10; hence, to reduce centesimal into sexagesimal subtract one-tenth; and to reduce sexagesimal into centesimal degrees, add one-ninth of the arc to itself.

Seconds, &c.

	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	
0	000000	017452	034899	052336	069756	087156	104528	121869	139173	156434	60
5	1454	8907	6353	3788	071207	8605	5975	3313	140613	7871	55
10	2909	020361	7806	5241	2658	090053	7421	4756	2053	9307	50
15	4363	1815	9260	6693	4108	1502	8867	6199	3493	160743	45
20	5818	3269	040713	8145	5559	2950	110313	7642	4932	2178	40
25	7272	4723	2166	9597	7009	4398	1758	9084	6371	3613	35
30	8727	6177	3619	061049	8459	5846	3203	130526	7809	5048	30
35	010181	7631	5072	2500	9909	7293	4648	1968	9248	6482	25
40	1635	9085	6525	3952	081359	8741	6093	3410	150686	7916	20
45	3090	030539	7978	5403	2808	100188	7537	4851	2123	9350	15
50	4544	1992	9431	6854	4258	1635	8982	6292	3561	170783	10
55	5998	3446	050883	8306	5707	3082	120426	7733	4998	2216	5
60	7452	4889	2336	9756	7156	4528	1869	9173	6434	3648	0
Cos. 89° 88° 87° 86° 85° 84° 83° 82° 81° 80°											
	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	
0	173648	190809	207912	224951	241922	258819	275637	292372	309017	325568	60
5	5080	2237	9334	6368	3333	260224	7035	3762	310400	6943	55
10	6512	3664	210756	7784	4743	1628	8432	5152	1782	8317	50
15	7944	5090	2178	9200	6153	3031	9629	6542	3164	9691	45
20	9375	6517	3599	230616	7563	4434	281225	7930	4545	331063	40
25	180805	7942	5019	2031	8972	5837	2620	9318	5925	2435	35
30	2236	9368	6440	3445	250380	7238	4015	300706	7305	3807	30
35	3665	200793	7859	4859	1788	8640	5410	2093	8684	5178	25
40	5095	2218	9279	6273	3195	270040	6803	3479	320062	6547	20
45	6524	3642	220697	7686	4602	1440	8196	4864	1439	7917	15
50	7953	5065	2116	9098	6008	2840	9589	6249	2816	9285	10
55	9381	6489	3534	240510	7414	4239	290981	7633	4193	340653	5
60	190809	7912	4951	1922	8819	5637	2372	9017	5568	2020	0
Cos. 79° 78° 77° 76° 75° 74° 73° 72° 71° 70°											
	20°	21°	22°	23°	24°	25°	26°	27°	28°	29°	
0	342020	358368	374607	390731	406737	422618	438371	453990	469472	484810	60
5	3387	9725	5955	2070	8065	3936	9678	5286	470755	6081	55
10	4752	361082	7302	3407	9392	5253	440984	6580	2038	7352	50
15	6117	2438	8649	4744	410719	6569	2289	7874	3320	8621	45
20	7481	3793	9994	6080	2045	7884	3593	9166	4600	9890	40
25	8845	5148	381339	7415	3369	9198	4896	460458	5880	491157	35
30	350207	6501	2683	8749	4693	430511	6198	1749	7159	2424	30
35	1569	7854	4027	400082	6016	1823	7499	3038	8436	3639	25
40	2931	9206	5369	1415	7338	3135	8799	4327	9713	4953	20
45	4291	370557	6711	2747	8660	4445	450098	5615	480989	6217	15
50	5651	1908	8052	4078	9980	5755	1397	6901	2263	7479	10
55	7010	3258	9392	5408	421300	7063	2694	8187	3537	8740	5
60	8368	4607	390731	6737	2618	8371	3990	9472	4810	500000	0
Cos. 69° 68° 67° 66° 65° 64° 63° 62° 61° 60°											
	30°	31°	32°	33°	34°	35°	36°	37°	38°	39°	
0	500000	515038	529919	544639	559193	573576	587785	601815	615661	629320	60
5	1259	6284	531152	5858	560398	4767	8961	2976	6807	630450	55
10	2517	7529	2384	7076	1602	5957	590136	4136	7951	1578	50
15	3774	8773	3615	8293	2805	7145	1310	5294	9094	2705	45
20	5030	520016	4844	9509	4007	8332	2482	6451	620235	3831	40
25	6285	1258	6072	550724	5207	9518	3653	7607	1376	4955	35
30	7538	2499	7300	1937	6406	580703	4823	8761	2515	6078	30
35	8791	3738	8526	3149	7604	1886	5991	9915	3652	7200	25
40	510043	4977	9751	4360	8801	3069	7159	611067	4789	8320	20
45	1293	6214	540974	5570	9997	4250	8325	2217	5923	9439	15
50	2543	7450	2197	6779	571191	5429	9489	3367	7057	640557	10
55	3791	8685	3419	7987	2384	6608	600653	4515	8189	1673	5
60	5038	9919	4639	9193	3576	7785	1815	5661	9320	2788	0
Cos. 59° 58° 57° 56° 55° 54° 53° 52° 51° 50°											

NATURAL SINES.

43

40°	41°	42°	43°	44°	45°	46°	47°	48°	49°	
642733	650059	669131	681998	694658	707107	719340	731354	743145	754710	60
3901	7156	670211	3061	5704	8134	720349	2345	4117	5663	55
3013	8252	1289	4123	6743	9161	1357	3334	5088	6615	50
6124	9346	2367	5183	7790	710185	2364	4323	6057	7565	45
7233	660439	3443	6242	8832	1209	3369	5309	7025	8514	40
8341	1530	4517	7299	9871	2230	4372	6294	7991	9461	35
9448	2620	5590	8355	700909	3250	5374	7277	8956	760406	30
650553	3709	6662	9409	1946	4269	6375	8259	9919	1350	25
1657	4796	7732	690462	2981	5286	7374	9239	750880	2292	20
2760	5882	8801	1513	4015	6302	8371	740218	1840	3232	15
3861	6866	9863	2563	5047	7316	9367	1195	2798	4171	10
4961	8049	680934	3611	6078	8329	730361	2171	3755	5109	5
6059	9131	1998	4658	7107	9340	1354	3135	4710	6044	0
49°	48°	47°	46°	45°	44°	43°	42°	41°	40°	
50°	51°	52°	53°	54°	55°	56°	57°	58°	59°	
766044	777146	788011	798636	809017	819152	829038	838671	848048	857167	60
6979	8060	8905	9510	9871	9985	9850	9462	8818	7915	55
7911	8973	9798	800383	810723	820817	830661	840251	9586	8682	50
8842	9834	790690	1254	1574	1647	1470	1039	850352	9496	45
9771	780794	1579	2123	2423	2475	2277	1825	1117	860149	40
770699	1702	2467	2991	3270	3302	3082	2609	1879	0890	35
1625	2608	3353	3857	4116	4126	3886	3391	2640	1629	30
2549	3513	4238	4721	4959	4949	4688	4172	3399	2366	25
3472	4416	5121	5584	5801	5770	5488	4951	4156	3102	20
4393	5317	6002	6445	6642	6590	6286	5728	4912	3836	15
5312	6217	6832	7304	7480	7407	7083	6503	5665	4567	10
6230	7114	7759	8161	8317	8223	7878	7277	6417	5297	5
7146	8011	8636	9017	9152	9038	8671	8048	7167	6025	0
39°	38°	37°	36°	35°	34°	33°	32°	31°	30°	
60°	61°	62°	63°	64°	65°	66°	67°	68°	69°	
866025	874620	882948	891007	898794	906308	913545	920505	927184	933580	60
6752	5324	3629	1666	9431	6922	4136	1072	7728	4101	55
7476	6026	4309	2323	900065	7533	4725	1638	8270	4619	50
8199	6727	4988	2979	0698	8143	5311	2201	8810	5135	45
8920	7425	5664	3632	1329	8751	5896	2762	9348	5650	40
9639	8122	6338	4284	1958	9357	6479	3322	9884	6162	35
870356	8817	7011	4934	2585	9961	7060	3880	930418	6672	30
1071	9510	7681	5582	3210	910563	7639	4435	0950	7181	25
1784	830201	8350	6229	3834	1164	8216	4989	1480	7687	20
2496	0891	9017	6873	4455	1762	8791	5541	2008	8191	15
3206	1578	9682	7515	5075	2358	9364	6090	2534	8694	10
3914	2264	890345	8156	5692	2953	9936	6638	3058	9194	5
4620	2948	1007	8794	6308	3545	920505	7184	3580	9693	0
29°	28°	27°	26°	25°	24°	23°	22°	21°	20°	
70°	71°	72°	73°	74°	75°	76°	77°	78°	79°	
939693	945519	951057	956305	961262	965926	970296	974370	978148	981627	60
40189	5991	1505	6729	1662	6301	0647	4696	8449	1904	55
0684	6462	1951	7151	2059	6675	0995	5020	8748	2178	50
1176	6930	2396	7571	2455	7046	1342	5342	9045	2450	45
1666	7397	2838	7990	2849	7415	1687	5662	9341	2721	40
2155	7861	3279	8406	3241	7782	2029	5900	9634	2989	35
2641	8324	3717	8820	3630	8148	2370	6296	9925	3255	30
3126	8784	4153	9232	4018	8511	2708	6610	980214	3519	25
3600	9243	4588	9642	4404	8872	3045	6921	0500	3781	20
4089	9699	5020	960050	4787	9231	3379	7231	0785	4041	15
4588	950154	5450	0456	5169	9588	3712	7539	1068	4298	10
5044	0606	5879	0860	5548	9943	4042	7844	1349	4554	5
5519	1057	6305	1262	5926	970296	4370	8143	1627	4808	0
19°	18°	17°	16°	15°	14°	13°	12°	11°	10°	

NATURAL COSINES.

G

	80°	81°	82°	83°	84°	85°	86°	87°	88°	89°
0	984808	987688	990268	992546	994522	996195	997564	998630	999391	9998
5	5059	7915	0469	2722	4673	6320	7664	8705	9441	98
10	5309	8139	0669	2896	4822	6444	7763	8778	9488	98
15	5556	8362	0866	3068	4969	6566	7859	8848	9534	98
20	5801	8582	1061	3238	5113	6685	7953	8917	9577	98
25	6045	8800	1254	3406	5256	6802	8045	8984	9618	98
30	6286	9016	1445	3572	5396	6917	8135	9048	9657	98
35	6525	9230	1634	3735	5535	7030	8223	9111	9694	98
40	6762	9442	1820	3897	5671	7141	8308	9171	9729	98
45	6996	9651	2005	4056	5805	7250	8392	9229	9762	98
50	7229	9859	2187	4214	5937	7357	8473	9285	9793	98
55	7460	99065	2368	4369	6067	7462	8552	9339	9821	98
60	7688	0268	2546	4522	6195	7564	8630	9391	9848	1.000
Con.	9°	8°	7°	6°	5°	4°	3°	2°	1°	0°

NATURAL COSINES.

NATURAL TANGENTS.

	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°
0	000000	017455	034921	052408	069927	087489	105104	122785	140541	1582
5	1454	8910	6377	3866	071389	8954	6575	4261	2024	98
10	2909	020365	7834	5325	2851	090421	8046	5738	3508	1611
15	4363	1820	9290	6784	4313	1887	9518	7216	4993	28
20	5818	3275	040747	8243	5775	3354	110990	8694	6478	42
25	7272	4731	2204	9703	7238	4821	2463	130173	7964	58
30	8727	6186	3661	061163	8702	6289	3936	1652	9451	73
35	010181	7641	5118	2623	080165	7757	5409	3132	150938	88
40	1636	9097	6576	4083	1629	9226	6883	4613	2426	1703
45	3091	030553	8033	5543	3094	100695	8358	6094	3915	11
50	4545	2009	9491	7004	4558	2164	9833	7576	5404	33
55	6000	3465	050949	8465	6023	3634	121309	9058	6894	48
60	7455	4921	2408	9927	7489	5104	2785	140541	8384	62
Cot.	89°	88°	87°	86°	85°	84°	83°	82°	81°	80°

	Tan 10°	11°	12°	13°	14°	15°	16°	17°	18°	19°
0	176327	194380	212557	230868	249328	267949	286745	305731	324920	3443
5	7827	5890	4077	2401	250873	9509	8320	7322	6528	58
10	9328	7401	5599	3934	2420	271069	9896	8914	8139	74
15	180830	8912	7121	5469	3968	2631	291473	310508	9751	92
20	2332	200425	8645	7004	5517	4194	3052	2104	331364	3508
25	3835	1938	220169	8541	7066	5759	4632	3701	2979	24
30	5339	3452	1695	240079	8618	7325	6214	5299	4595	41
35	6844	4967	3221	1618	260170	8892	7796	6899	6213	57
40	8350	6483	4749	3157	1723	280460	9380	8500	7833	73
45	9856	8000	6277	4698	3278	2029	300966	320103	9454	90
50	191363	9518	7806	6241	4834	3600	2553	1707	341077	3608
55	2871	211037	9337	7784	6391	5172	4141	3318	2702	23
60	4380	2557	230868	9328	7949	6745	5731	4920	4328	38
Cot.	79°	78°	77°	76°	75°	74°	73°	72°	71°	70°

	Tan 20°	21°	22°	23°	24°	25°	26°	27°	28°	29°
0	363970	383864	404026	424475	445229	466308	487733	509525	531709	5543
5	5618	5534	5719	6192	6973	8080	9534	511359	3577	62
10	7268	7205	7414	7912	8719	9854	491339	3195	5447	81
15	8920	8879	9111	9634	450467	471631	3145	5034	7319	5600
20	370573	390554	410810	431358	2218	3410	4955	6876	9195	19
25	2228	2231	2511	3084	3971	5191	6767	8720	541074	38
30	3885	3910	4214	4812	5726	6976	8582	520567	2956	57
35	5543	5592	5919	6543	7484	8762	500399	2417	4840	76
40	7204	7275	7626	8276	9244	480551	2219	4270	6728	96
45	8866	8960	9335	440011	461006	2343	4042	6126	8619	5713
50	330530	400646	421046	1748	2771	4137	5867	7984	550513	34
55	2196	2335	2759	3487	4538	5933	7695	9845	2409	54
60	3864	4026	4475	5229	6308	7733	9525	531709	4309	7
Cot.	69°	68°	67°	66°	65°	64°	63°	62°	61°	60°

NATURAL COTANGENTS.

NATURAL TANGENTS.

45

	30°	31°	32°	33°	34°	35°	36°	37°	
0	577330	600861	624869	649408	674509	700208	726543	753554	60
5	92911	2842	6894	651477	6627	2377	8767	5837	55
0	581233	4827	8921	3551	8749	4551	730996	8125	50
5	3183	6815	630953	5629	680876	6730	3230	760418	45
0	5134	8807	2938	7710	3007	8913	5469	2716	40
5	7083	610802	5027	9796	5142	711101	7713	5019	35
0	9045	2801	7070	661886	7281	3293	9961	7327	30
5	591006	4803	9117	3979	9425	5430	742214	9640	25
0	2970	6809	641167	6077	691572	7691	4472	771959	20
5	4938	8819	3222	8179	3725	9897	6735	4283	15
0	6908	620832	5280	670285	5881	722108	9003	6612	10
5	8883	2849	7342	2394	8042	4323	751276	8946	5
0	600861	4869	9408	4509	700208	6543	3554	781236	0
ot.	59°	58°	57°	56°	55°	54°	53°	52°	
an.	38°	39°	40°	41°	42°	43°	44°	45°	
0	781286	809784	839100	869287	900404	932515	965689	1.000000	60
5	3631	812195	841581	871844	3041	5238	8504	002913	55
0	5981	4612	4069	4407	5685	7968	971326	005835	50
5	8336	7034	6563	6977	8336	940706	4157	008765	45
0	790698	9463	9062	9553	910994	3451	6996	011704	40
5	3064	821897	851568	882136	3659	6204	9842	014651	35
0	5436	4336	4081	4725	6331	8965	982697	017607	30
5	7813	6782	6599	7322	9010	951733	5560	020572	25
0	800196	9234	9124	9924	921697	4508	8432	023546	20
5	2585	831691	861655	892534	4391	7292	991311	026529	15
0	4979	4155	4193	5151	7091	960083	4199	029620	10
5	7379	6624	6736	7774	9800	2882	7095	032521	5
0	9784	9100	9287	900404	932515	5689	1.000000	035530	0
ot.	51°	50°	49°	48°	47°	46°	45°	44°	
an.	46°	47°	48°	49°	50°	51°	52°	53°	
0	1.035530	1.072369	1.110613	1.150368	1.191754	1.234897	1.279942	1.327045	60
5	038549	075501	113866	153753	195280	238576	283786	331068	55
0	041577	078642	117131	157150	198818	242269	287645	335108	50
5	044614	081794	120405	160557	202360	245974	291518	339162	45
0	047660	084955	123691	163076	205933	249693	295406	343233	40
5	050715	088127	126987	167407	209509	253426	299308	347320	35
0	053780	091309	130294	170850	213097	257172	303225	351422	30
5	056854	094500	133612	174304	216698	260932	307158	355541	25
0	059938	097702	136941	177770	220312	264706	311105	359676	20
5	063031	100914	140282	181248	223939	268494	315067	363828	15
0	066134	104137	143633	184738	227579	272296	319044	367996	10
5	069247	107369	146995	188240	231231	276112	323037	372181	5
0	072369	110613	150368	191754	234897	279942	327045	376382	0
ot.	43°	42°	41°	40°	39°	38°	37°	36°	
an.	54°	55°	56°	57°	58°	59°	60°	61°	
0	1.376382	1.428148	1.482561	1.539865	1.600335	1.664280	1.732051	1.804048	60
5	380600	432578	487222	544779	605526	669776	737883	810252	55
0	384835	437027	491904	549716	610742	675299	743745	816489	50
5	389088	441494	496606	554674	615982	680849	749637	822759	45
0	393357	445980	501328	559655	621247	686426	755559	829063	40
5	397644	450485	506071	564659	626537	692031	761511	835400	35
0	401948	455009	510835	569686	631852	697663	767494	841771	30
5	406270	459552	515620	574735	637192	703323	773508	848176	25
0	410610	464115	520426	579808	642558	709012	779552	854616	20
5	414967	468697	525254	584904	647949	714728	785629	861091	15
0	419343	473298	530102	590024	653366	720474	791736	867600	10
5	423736	477920	534973	595167	658810	726248	797876	874146	5
0	428148	482561	539865	600335	664280	732051	804048	880727	0
	35°	34°	33°	32°	31°	30°	29°	28°	

NATURAL COTANGENTS.

	62°	63°	64°	65°	66°	67°	68°	69°	
0	1.880727	1.962611	2.050304	2.144507	2.246037	2.355852	2.475087	2.605089	60
5	887344	969687	057895	152676	254857	365412	485489	616457	55
10	893997	976805	065532	160896	263736	375037	495966	627912	50
15	900687	983964	073215	169168	272673	384729	506520	639455	45
20	907415	991164	080944	177492	281669	394489	517151	651087	40
25	914179	998406	088720	185869	290726	404317	527860	662809	35
30	920982	2.005690	096544	194300	299843	414214	538648	674622	30
35	927823	013016	104415	202784	309021	424180	549516	686527	25
40	934702	020336	112335	211323	318261	434217	560465	698525	20
45	941620	027799	120303	219918	327563	444326	571496	710619	15
50	948577	035257	128321	228568	336929	454506	582609	722808	10
55	955574	042758	136389	237274	346358	464760	593807	735093	5
60	962611	050304	144507	246037	355852	475087	605089	747477	0
Cot. 27° 26° 25° 24° 23° 22° 21° 20°									
Tan. 70° 71° 72° 73° 74° 75° 76° 77°									
0	2.747477	2.904211	3.077684	3.270853	3.487414	3.732051	4.010781	4.331476	60
5	759961	917991	092993	287949	506656	753882	035778	360400	55
10	772545	931889	108421	305209	526094	775952	061070	389694	50
15	785231	945905	123999	322636	545733	792266	086663	419364	45
20	798020	960042	139719	340233	565575	820828	112561	449418	40
25	810913	974302	155584	358001	585624	843642	135772	479864	35
30	823913	988685	171595	375943	605884	866713	165300	510709	30
35	837020	3.003194	187754	394063	626357	890045	192151	541961	25
40	850235	017830	204064	412363	647047	913642	219332	573629	20
45	863560	032595	220526	430845	667958	937509	246848	605721	15
50	876997	047492	237144	449512	689093	961652	274707	638246	10
55	890547	062520	253918	468368	710456	986074	302914	671212	5
60	904211	077684	270853	487414	732051	4.010781	331476	704630	0
Cot. 19° 18° 17° 16° 15° 14° 13° 12°									
Tan. 78° 79° 80° 81° 82° 83° 84° 85°									
0	4.704630	5.144554	5.671282	6.313752	7.115370	8.144346	9.514365	11.43005	60
5	738508	184804	719917	373736	191246	243449	649348	624765	55
10	772857	225665	769369	434843	268726	344956	789173	826177	50
15	807685	267152	819657	497104	347861	448957	931009	12.03463	45
20	843005	309279	870804	560554	428706	555547	10.07803	25051	40
25	878825	352063	922832	625226	511318	664822	22943	47422	35
30	915157	395517	975764	691156	595754	776887	38540	70620	30
35	952013	439659	6.029625	758383	682077	891851	54615	94692	25
40	989403	484505	084438	826944	770351	9.009826	71191	13.19688	20
45	5.027340	530072	140230	896890	860642	130935	88292	45663	15
50	065835	576379	197028	968234	953022	255304	11.05943	72674	10
55	104902	623442	254859	7.041048	8.047565	383066	24171	14.00786	5
60	144554	671282	313752	115370	144346	514365	43005	30067	0
Cot. 11° 10° 9° 8° 7° 6° 5° 4°									
Tan. 86° Diff. 87° Diff. 88° Diff. 89° Diff.									
0	14.30067	30525	19.08114	54616	28.63625	1.24605	57.28996	5.20919	60
5	60592	31850	62730	57825	29.88230	1.35928	62.49915	6.25094	55
10	92442	33263	20.20555	61328	31.24158	1.48868	68.75009	7.63992	50
15	15.25705	34773	81883	65157	32.73026	1.63751	76.39001	9.54978	45
20	60478	36339	21.47040	69358	34.36777	1.80983	85.93979	12.2782	40
25	96867	38119	22.16398	73979	36.17760	2.01086	98.21794	16.3708	35
30	16.34986	39975	90377	79077	38.18846	2.24738	114.5887	22.9188	30
35	74961	41973	23.69454	84722	40.43584	2.52824	137.5075	34.3779	25
40	17.16934	44122	24.54176	90994	42.96408	2.86527	171.8854	57.2963	20
45	61056	46442	25.45170	97990	45.82935	3.27453	229.1817	114.5920	15
50	18.07498	48949	26.43160	1.05825	49.10388	3.77623	343.7737	343.7752	10
55	56447	51667	27.48985	1.14640	52.88211	4.40785	687.5489	Infinite.	5
60	19.06114		28.63625		57.28996		Infinite.		0
Cot. 3° Diff. 2° Diff. 1° Diff. 0° Diff.									

A TABLE

OF THE

AREAS OF CIRCULAR SEGMENTS.

Height.	Area.	Height.	Area.	Height.	Area.	Height.	Area.	Height.	Area.
.001	.000042	.051	.015119	.101	.041476	.151	.074589	.201	.112624
.002	.000119	.052	.015561	.102	.042080	.152	.075306	.202	.113426
.003	.000219	.053	.016007	.103	.042687	.153	.076026	.203	.114230
.004	.000337	.054	.016457	.104	.043296	.154	.076747	.204	.115035
.005	.000470	.055	.016911	.105	.043908	.155	.077469	.205	.115842
.006	.000618	.056	.017369	.106	.044522	.156	.078194	.206	.116650
.007	.000779	.057	.017831	.107	.045139	.157	.078921	.207	.117460
.008	.000951	.058	.018296	.108	.045759	.158	.079649	.208	.118271
.009	.001135	.059	.018766	.109	.046381	.159	.080380	.209	.119084
.010	.001329	.060	.019239	.110	.047005	.160	.081112	.210	.119897
.011	.001533	.061	.019716	.111	.047632	.161	.081846	.211	.120712
.012	.001746	.062	.020196	.112	.048262	.162	.082582	.212	.121529
.013	.001969	.063	.020691	.113	.048894	.163	.083320	.213	.122347
.014	.002199	.064	.021168	.114	.049528	.164	.084059	.214	.123167
.015	.002438	.065	.021659	.115	.050165	.165	.084801	.215	.123988
.016	.002685	.066	.022154	.116	.050804	.166	.085544	.216	.124810
.017	.002940	.067	.022652	.117	.051446	.167	.086289	.217	.125634
.018	.003202	.068	.023154	.118	.052090	.168	.087036	.218	.126459
.019	.003471	.069	.023659	.119	.052736	.169	.087785	.219	.127285
.020	.003748	.070	.024168	.120	.053385	.170	.088535	.220	.128113
.021	.004031	.071	.024680	.121	.054036	.171	.089287	.221	.128942
.022	.004322	.072	.025195	.122	.054689	.172	.090041	.222	.129773
.023	.004618	.073	.025714	.123	.055345	.173	.090797	.223	.130605
.024	.004921	.074	.026236	.124	.056003	.174	.091554	.224	.131438
.025	.005230	.075	.026761	.125	.056663	.175	.092313	.225	.132272
.026	.005546	.076	.027289	.126	.057326	.176	.093074	.226	.133108
.027	.005867	.077	.027821	.127	.057991	.177	.093836	.227	.133945
.028	.006194	.078	.028356	.128	.058658	.178	.094601	.228	.134784
.029	.006527	.079	.028894	.129	.059327	.179	.095366	.229	.135624
.030	.006865	.080	.029435	.130	.059999	.180	.096134	.230	.136465
.031	.007209	.081	.029979	.131	.060672	.181	.096904	.231	.137307
.032	.007558	.082	.030526	.132	.061348	.182	.097674	.232	.138150
.033	.007913	.083	.031076	.133	.062026	.183	.098447	.233	.138995
.034	.008273	.084	.031629	.134	.062707	.184	.099221	.234	.139841
.035	.008638	.085	.032186	.135	.063389	.185	.099997	.235	.140688
.036	.009008	.086	.032745	.136	.064074	.186	.100774	.236	.141537
.037	.009383	.087	.033307	.137	.064760	.187	.101553	.237	.142387
.038	.009763	.088	.033872	.138	.065449	.188	.102334	.238	.143238
.039	.010148	.089	.034441	.139	.066140	.189	.103116	.239	.144091
.040	.010537	.090	.035011	.140	.066833	.190	.103900	.240	.144944
.041	.010931	.091	.035585	.141	.067528	.191	.104685	.241	.145799
.042	.011330	.092	.036162	.142	.068225	.192	.105472	.242	.146655
.043	.011734	.093	.036741	.143	.068924	.193	.106261	.243	.147512
.044	.012142	.094	.037323	.144	.069625	.194	.107051	.244	.148371
.045	.012554	.095	.037909	.145	.070328	.195	.107842	.245	.149230
.046	.012971	.096	.038497	.146	.071033	.196	.108635	.246	.150091
.047	.013392	.097	.039087	.147	.071741	.197	.109431	.247	.150953
.048	.013818	.098	.039680	.148	.072450	.198	.110226	.248	.151816
.049	.014247	.099	.040276	.149	.073161	.199	.111025	.249	.152680
.050	.014681	.100	.040875	.150	.073874	.200	.111823	.250	.153546

Height.	Area.	Height.	Area.	Height.	Area.	Height.	Area.	Height.	Area.
.251	.154412	.301	.199085	.351	.245934	.401	.294349	.451	.343777
.252	.155280	.302	.200003	.352	.246889	.402	.295330	.452	.344772
.253	.156149	.303	.200922	.353	.247845	.403	.296311	.453	.345768
.254	.157019	.304	.201841	.354	.248801	.404	.297292	.454	.346764
.255	.157890	.305	.202761	.355	.249757	.405	.298273	.455	.347759
.256	.158762	.306	.203683	.356	.250715	.406	.299255	.456	.348755
.257	.159636	.307	.204605	.357	.251673	.407	.300238	.457	.349752
.258	.160510	.308	.205527	.358	.252631	.408	.301220	.458	.350748
.259	.161386	.309	.206451	.359	.253590	.409	.302203	.459	.351745
.260	.162263	.310	.207376	.360	.254550	.410	.303187	.460	.352742
.261	.163140	.311	.208301	.361	.255510	.411	.304171	.461	.353739
.262	.164019	.312	.209227	.362	.256471	.412	.305155	.462	.354736
.263	.164899	.313	.210154	.363	.257433	.413	.306140	.463	.355732
.264	.165780	.314	.211083	.364	.258395	.414	.307125	.464	.356730
.265	.166663	.315	.212011	.365	.259357	.415	.308110	.465	.357727
.266	.167546	.316	.212940	.366	.260320	.416	.309095	.466	.358725
.267	.168430	.317	.213871	.367	.261284	.417	.310081	.467	.359723
.268	.169316	.318	.214802	.368	.262248	.418	.311068	.468	.360721
.269	.170202	.319	.215733	.369	.263213	.419	.312054	.469	.361719
.270	.171089	.320	.216666	.370	.264178	.420	.313041	.470	.362717
.271	.171978	.321	.217599	.371	.265144	.421	.314029	.471	.363715
.272	.172867	.322	.218533	.372	.266111	.422	.315016	.472	.364713
.273	.173758	.323	.219468	.373	.267078	.423	.316004	.473	.365712
.274	.174649	.324	.220404	.374	.268045	.424	.316992	.474	.366710
.275	.175542	.325	.221341	.375	.269013	.425	.317981	.475	.367709
.276	.176435	.326	.222277	.376	.269982	.426	.318970	.476	.368708
.277	.177330	.327	.223215	.377	.270951	.427	.319959	.477	.369707
.278	.178225	.328	.224154	.378	.271920	.428	.320948	.478	.370706
.279	.179122	.329	.225093	.379	.272890	.429	.321938	.479	.371705
.280	.180019	.330	.226033	.380	.273861	.430	.322928	.480	.372704
.281	.180918	.331	.226974	.381	.274832	.431	.323918	.481	.373703
.282	.181818	.332	.227915	.382	.275803	.432	.324909	.482	.374702
.283	.182718	.333	.228858	.383	.276775	.433	.325900	.483	.375702
.284	.183619	.334	.229801	.384	.277748	.434	.326892	.484	.376702
.285	.184521	.335	.230745	.385	.278721	.435	.327882	.485	.377701
.286	.185425	.336	.231689	.386	.279694	.436	.328874	.486	.378701
.287	.186329	.337	.232634	.387	.280668	.437	.329866	.487	.379700
.288	.187234	.338	.233580	.388	.281642	.438	.330858	.488	.380700
.289	.188140	.339	.234526	.389	.282617	.439	.331850	.489	.381699
.290	.189047	.340	.235473	.390	.283592	.440	.332843	.490	.382699
.291	.189955	.341	.236421	.391	.284568	.441	.333836	.491	.383699
.292	.190864	.342	.237369	.392	.285544	.442	.334829	.492	.384699
.293	.191775	.343	.238318	.393	.286521	.443	.335822	.493	.385699
.294	.192684	.344	.239268	.394	.287498	.444	.336816	.494	.386699
.295	.193596	.345	.240218	.395	.288476	.445	.337810	.495	.387699
.296	.194509	.346	.241169	.396	.289454	.446	.338804	.496	.388699
.297	.195422	.347	.242121	.397	.290432	.447	.339798	.497	.389699
.298	.196337	.348	.243074	.398	.291411	.448	.340793	.498	.390699
.299	.197252	.349	.244026	.399	.292390	.449	.341787	.499	.391699
.300	.198168	.350	.244980	.400	.293369	.450	.342782	.500	.392699

TABLE

OF

SQUARES, CUBES, SQUARE ROOTS, AND CUBE ROOTS.

No.	Square.	Cube.	Square Root.	Cube Root.	No.	Square.	Cube.	Square Root.	Cube Root.
1	1	1	1.000000	1.000000	53	2809	148877	7.280110	3.756286
2	4	8	1.414214	1.259921	54	2916	157464	7.348469	3.779763
3	9	27	1.732051	1.422500	55	3025	166375	7.416198	3.802953
4	16	64	2.000000	1.587401	56	3136	175616	7.483315	3.825862
5	25	125	2.236068	1.709976	57	3249	185193	7.549834	3.848501
6	36	216	2.449490	1.817121	58	3364	195112	7.615773	3.870877
7	49	343	2.645751	1.912931	59	3481	205379	7.681146	3.892996
8	64	512	2.828427	2.000000	60	3600	216000	7.745967	3.914868
9	81	729	3.000000	2.080084	61	3721	226961	7.810250	3.936497
10	100	1000	3.162278	2.154435	62	3844	238328	7.874008	3.957892
11	121	1331	3.316625	2.223980	63	3969	250047	7.937254	3.979057
12	144	1728	3.464102	2.289429	64	4096	262144	8.000000	4.000000
13	169	2197	3.605551	2.351335	65	4225	274625	8.062258	4.020726
14	196	2744	3.741657	2.410142	66	4356	287496	8.124038	4.041240
15	225	3375	3.872983	2.466212	67	4489	300763	8.185353	4.061548
16	256	4096	4.000000	2.519842	68	4624	314432	8.246211	4.081655
17	289	4913	4.123106	2.571282	69	4761	328509	8.306624	4.101566
18	324	5832	4.242641	2.620741	70	4900	343000	8.366600	4.121285
19	361	6859	4.358899	2.668402	71	5041	357911	8.426150	4.140818
20	400	8000	4.472136	2.714418	72	5184	373248	8.485281	4.160168
21	441	9261	4.582576	2.758924	73	5329	389017	8.544004	4.179339
22	484	10648	4.690416	2.802039	74	5476	405224	8.602325	4.198336
23	529	12167	4.795832	2.843867	75	5625	421875	8.660254	4.217163
24	576	13824	4.898979	2.884499	76	5776	438976	8.717798	4.235824
25	625	15625	5.000000	2.924018	77	5929	456533	8.774964	4.254321
26	676	17576	5.099020	2.962496	78	6084	474552	8.831761	4.272659
27	729	19683	5.196152	3.000000	79	6241	493039	8.888194	4.290840
28	784	21952	5.291503	3.036589	80	6400	512000	8.944272	4.308870
29	841	24389	5.385165	3.072317	81	6561	531441	9.000000	4.326749
30	900	27000	5.477226	3.107232	82	6724	551368	9.055385	4.344481
31	961	29791	5.567764	3.141381	83	6889	571787	9.110434	4.362071
32	1024	32768	5.656854	3.174802	84	7056	592704	9.165151	4.379519
33	1089	35937	5.744563	3.207534	85	7225	614125	9.219544	4.396830
34	1156	39304	5.830952	3.239612	86	7396	636056	9.273618	4.414005
35	1225	42875	5.916080	3.271066	87	7569	658503	9.327379	4.431048
36	1296	46656	6.000000	3.301927	88	7744	681472	9.380432	4.447960
37	1369	50653	6.082763	3.332222	89	7921	704969	9.433981	4.464745
38	1444	54872	6.164414	3.361975	90	8100	729000	9.486833	4.481405
39	1521	59319	6.244998	3.391211	91	8281	753571	9.539392	4.497941
40	1600	64000	6.324555	3.419952	92	8464	778688	9.591663	4.514357
41	1681	68921	6.403124	3.448217	93	8649	804357	9.643651	4.530655
42	1764	74088	6.480741	3.476027	94	8836	830584	9.695360	4.546836
43	1849	79507	6.557439	3.503398	95	9025	857375	9.746794	4.562903
44	1936	85184	6.633250	3.530348	96	9216	884736	9.797959	4.578857
45	2025	91125	6.708204	3.556893	97	9409	912673	9.848858	4.594701
46	2116	97336	6.782330	3.583048	98	9604	941192	9.899495	4.610436
47	2209	103823	6.855655	3.608826	99	9801	970299	9.949874	4.626065
48	2304	110592	6.928203	3.634241	100	10000	1000000	10.000000	4.641588
49	2401	117649	7.000000	3.659306	101	10201	1030301	10.049876	4.657010
50	2500	125000	7.071068	3.684031	102	10404	1061208	10.099505	4.672325
51	2601	132651	7.141428	3.708430	103	10609	1092727	10.148882	4.687529
52	2704	140608	7.211103	3.732511	104	10816	1124884	10.198039	4.702

No.	Square.	Cube.	Square Root.	Cube Root.	No.	Square.	Cube.	Square Root.	Cube Root.
105	11025	1157625	10.246951	4.717694	169	28561	4826809	13.000000	5.526778
106	11236	1191016	10.295630	4.732624	170	28900	4913000	13.038405	5.539650
107	11449	1225043	10.344080	4.747459	171	29241	5000211	13.076697	5.550499
108	11664	1259712	10.392305	4.762203	172	29584	5088448	13.114877	5.561298
109	11881	1295029	10.440306	4.776856	173	29929	5177717	13.152946	5.572055
110	12100	1331000	10.488088	4.791420	174	30276	5268024	13.190906	5.582770
111	12321	1367631	10.535654	4.805896	175	30625	5359375	13.228757	5.593445
112	12544	1404928	10.583005	4.820284	176	30976	5451776	13.266499	5.604079
113	12769	1442897	10.630146	4.834588	177	31329	5545233	13.304135	5.614672
114	12996	1481544	10.677078	4.848808	178	31684	5639752	13.341664	5.625226
115	13225	1520375	10.723805	4.862944	179	32041	5735339	13.379088	5.635741
116	13456	1560396	10.770330	4.876999	180	32400	5832000	13.416406	5.646216
117	13689	1601613	10.816654	4.890973	181	32761	5929741	13.453624	5.656653
118	13924	1643032	10.862700	4.904866	182	33124	6028568	13.490738	5.667051
119	14161	1685159	10.908712	4.918685	183	33489	6128487	13.527749	5.677411
120	14400	1728000	10.954451	4.932424	184	33856	6229504	13.564660	5.687734
121	14641	1771561	11.000000	4.946087	185	34225	6331625	13.601470	5.698019
122	14884	1815848	11.045361	4.959676	186	34596	6434856	13.638182	5.708267
123	15129	1860867	11.090536	4.973190	187	34969	6539203	13.674794	5.718479
124	15376	1906624	11.135529	4.986631	188	35344	6644672	13.711309	5.728654
125	15625	1953125	11.180340	5.000000	189	35721	6751269	13.747727	5.738794
126	15876	2000376	11.224972	5.013298	190	36100	6859000	13.784049	5.748897
127	16129	2048383	11.269428	5.026526	191	36481	6967871	13.820275	5.758965
128	16384	2097152	11.313708	5.039684	192	36864	7077888	13.856406	5.768998
129	16641	2146689	11.357817	5.052774	193	37249	7189057	13.892444	5.778997
130	16900	2197000	11.401754	5.065797	194	37636	7301384	13.928388	5.788960
131	17161	2248091	11.445523	5.078753	195	38025	7414875	13.964240	5.798890
132	17424	2299968	11.489125	5.091643	196	38416	7529536	14.000000	5.808788
133	17689	2352637	11.532563	5.104469	197	38809	7645373	14.035669	5.818648
134	17956	2406104	11.575837	5.117230	198	39204	7762392	14.071247	5.828477
135	18225	2460375	11.618950	5.129928	199	39601	7880599	14.106736	5.838272
136	18496	2515456	11.661904	5.142563	200	40000	8000000	14.142136	5.848035
137	18769	2571353	11.704700	5.155137	201	40401	8120601	14.177447	5.857766
138	19044	2628072	11.747344	5.167649	202	40804	8242408	14.212670	5.867464
139	19321	2685619	11.789826	5.180101	203	41209	8365427	14.247807	5.877130
140	19600	2744000	11.832160	5.192494	204	41616	8489664	14.282857	5.886765
141	19881	2803221	11.874342	5.204828	205	42025	8615125	14.317821	5.896368
142	20164	2863288	11.916375	5.217103	206	42436	8741816	14.352700	5.905941
143	20449	2924207	11.958261	5.229321	207	42849	8869743	14.387495	5.915482
144	20736	2985984	12.000000	5.241483	208	43264	8998912	14.422205	5.924992
145	21025	3048625	12.041595	5.253588	209	43681	9129329	14.456832	5.934473
146	21316	3112136	12.083049	5.265637	210	44100	9261000	14.491377	5.943922
147	21609	3176523	12.124356	5.277632	211	44521	9393931	14.525839	5.953342
148	21904	3241792	12.165525	5.289572	212	44944	9528128	14.560220	5.962731
149	22201	3307949	12.206556	5.301450	213	45369	9663597	14.594520	5.972091
150	22500	3375000	12.247449	5.313293	214	45796	9800344	14.628739	5.981426
151	22801	3442951	12.288206	5.325074	215	46225	9938375	14.662878	5.990727
152	23104	3511808	12.328828	5.336803	216	46656	10077696	14.696939	6.000000
153	23409	3581577	12.369317	5.348481	217	47089	10218313	14.730920	6.009244
154	23716	3652264	12.409674	5.360100	218	47524	10360232	14.764823	6.018463
155	24025	3723875	12.449900	5.371685	219	47961	10503459	14.798649	6.027650
156	24336	3796416	12.489996	5.383213	220	48400	10648000	14.832397	6.036811
157	24649	3869893	12.529964	5.394691	221	48841	10793861	14.866069	6.045943
158	24964	3944312	12.569805	5.406120	222	49284	10941048	14.899664	6.055048
159	25281	4019679	12.609520	5.417501	223	49729	11089567	14.933185	6.064126
160	25600	4096000	12.649111	5.428835	224	50176	11239424	14.966630	6.073176
161	25921	4173281	12.688577	5.440122	225	50625	11390625	15.000000	6.082201
162	26244	4251528	12.727922	5.451362	226	51076	11543176	15.033296	6.091199
163	26569	4330747	12.767145	5.462556	227	51529	11697083	15.066519	6.100170
164	26896	4410944	12.806248	5.473704	228	51984	11852352	15.099669	6.109113
165	27225	4492125	12.845233	5.484807	229	52441	12008989	15.132746	6.118033
166	27556	4574296	12.884099	5.495865	230	52900	12167000	15.165751	6.126923
167	27889	4657463	12.922848	5.506878	231	53361	12326391	15.198684	6.135783
168	28224	4741632	12.961481	5.517848	232	53824	12487168	15.231546	6.144623

Square.	Cube.	Square Root.	Cube Root.	No.	Square.	Cube.	Square Root.	Cube Root.
54289	12649337	15264338	6153449	297	88209	26198073	17233688	6671940
54756	12812904	15297059	6162240	298	88804	26463592	17262676	6679420
55225	12977875	15329710	6171066	299	89401	26730899	17291617	6686883
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63001	15813251	15842980	6307994	315	99225	31255875	17748239	6804092
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73984	20123648	16492423	6479224	336	112896	37933056	18330303	6952053
74529	20346417	16522712	6487154	337	113569	38272753	18357560	6958943
75076	20570824	16552945	6495065	338	114244	38614472	18384776	6965820
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79524	22425768	16792856	6557672	346	119716	41421736	18601075	7020349
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82944	23887872	16970563	6603854	352	123904	43614208	18761663	7060697
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84681	24642171	17058722	6626705	355	126025	44738875	18841444	7080699
85264	24897088	17088008	6634287	356	126736	45118016	18867962	7087341
85849	25153757	17117243	6641852	357	127449	45499293	18894444	7093971
86436	25412184	17146428	6649400	358	128164	45882712	18920888	7100583
87025	25672375	17175564	6656930	359	128881	46268279	18947295	7107184
87616	25934336	17204651	6664444	360	129600	46655000	18973666	7113787

No.	Square.	Cube.	Square Root.	Cube Root.	No.	Square.	Cube.	Square Root.	Cube Root.
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363	131769	47832147	19-052559	7-133492	427	182329	77854433	20-663978	7-530248
364	132496	48228544	19-078784	7-140037	428	183184	78402752	20-688161	7-536122
365	133225	48627125	19-104973	7-146569	429	184041	78953589	20-712315	7-541907
366	133956	49027896	19-131127	7-153090	430	184900	79507000	20-736441	7-547842
367	134689	49430863	19-157244	7-159599	431	185761	80062991	20-760540	7-553689
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369	136161	50243409	19-209373	7-172581	433	187489	81182737	20-808652	7-565355
370	136900	50653000	19-235384	7-179054	434	188356	81746504	20-832667	7-571174
371	137641	51064811	19-261360	7-185516	435	189225	82312875	20-856654	7-576985
372	138384	51478848	19-287302	7-191966	436	190096	82881856	20-880613	7-582786
373	139129	51895117	19-313208	7-198405	437	190969	83453453	20-904545	7-588579
374	139876	52313624	19-339080	7-204832	438	191844	84027672	20-928450	7-594363
375	140625	52734375	19-364917	7-211248	439	192721	84604519	20-952327	7-600138
376	141376	53157376	19-390719	7-217652	440	193600	85184000	20-976177	7-605905
377	142129	53582633	19-416483	7-224045	441	194481	85766121	21-000000	7-611683
378	142884	54010152	19-442222	7-230427	442	195364	86350338	21-023796	7-617412
379	143641	54439939	19-467922	7-236797	443	196249	86936307	21-047565	7-623132
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381	145161	55306341	19-519221	7-249504	445	198025	88112125	21-095023	7-634607
382	145924	55742968	19-544820	7-255841	446	198916	88716536	21-118712	7-640321
383	146689	56181887	19-570386	7-262167	447	199809	89314623	21-142375	7-646027
384	147456	56623104	19-595918	7-268482	448	200704	89915392	21-166011	7-651725
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386	148996	57512456	19-646883	7-281079	450	202500	91125000	21-213203	7-663094
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395	156025	61629875	19-874607	7-337234	459	210681	96702579	21-424285	7-713843
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397	157609	62570773	19-924859	7-349597	461	212521	97972181	21-470911	7-725032
398	158404	63044792	19-949937	7-355762	462	213444	98611128	21-494185	7-730614
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401	160801	64481201	20-024984	7-374196	465	216225	100544625	21-563859	7-747311
402	161604	64964808	20-049938	7-380323	466	217156	101194696	21-587033	7-752861
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404	163216	65939264	20-099751	7-392542	468	219024	102503232	21-633308	7-763926
405	164025	66430125	20-124612	7-398636	469	219961	103161709	21-656408	7-769463
406	164836	66923416	20-149442	7-404721	470	220900	103823900	21-679483	7-774990
407	165649	67419143	20-174241	7-410795	471	221841	104487111	21-702534	7-780490
408	166464	67917312	20-199010	7-416859	472	222784	105154048	21-725561	7-785993
409	167281	68417929	20-223748	7-422914	473	223729	105823817	21-748563	7-791487
410	168100	68921000	20-248457	7-428959	474	224676	106496424	21-771541	7-796974
411	168921	69426531	20-273135	7-434994	475	225625	107171875	21-794495	7-802444
412	169744	69934528	20-297783	7-441019	476	226576	107850176	21-817424	7-807925
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414	171396	70957944	20-346990	7-453040	478	228484	109215352	21-863211	7-818840
415	172225	71473375	20-371549	7-459036	479	229441	109902239	21-886069	7-824294
416	173056	71991296	20-396078	7-465022	480	230400	110592000	21-908902	7-829735
417	173889	72511713	20-420578	7-470999	481	231361	111284611	21-931712	7-835160
418	174724	73034632	20-445048	7-476966	482	232324	111980168	21-954498	7-840593
419	175561	73560059	20-469490	7-482924	483	233289	112678587	21-977261	7-846013
420	176400	74088000	20-493902	7-488872	484	234256	113379904	22-000000	7-851424
421	177241	74618461	20-518285	7-494811	485	235225	114084125	22-022716	7-856823
422	178084	75151448	20-542639	7-500741	486	236196	114791256	22-045408	7-862223
423	178929	75686967	20-566964	7-506661	487	237169	115501303	22-068077	7-867623
424	179776	76225024	20-591260	7-512571	488	238144	116214272	22-090732	7-873023

Square.	Cube.	Square Root.	Cube Root.	No.	Square.	Cube.	Square Root.	Cube Root.
239121	116930169	22-113344	7-078368	553	305809	169112377	23-515952	8-208082
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241081	118370771	22-158520	7-889095	555	308025	170953875	23-558438	8-217966
242064	119095488	22-181073	7-894447	556	309136	171879616	23-579652	8-222898
243049	119823157	22-203603	7-899792	557	310249	172808693	23-600847	8-227825
244036	120553784	22-226111	7-905129	558	311364	173741112	23-622024	8-232746
245025	121287375	22-248596	7-910460	559	312481	174676879	23-643181	8-237661
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248004	123505992	22-315914	7-926408	562	315844	177504328	23-706539	8-252371
249001	124251499	22-338308	7-931710	563	316969	178453547	23-727621	8-257263
250000	125000000	22-360630	7-937005	564	318096	179406144	23-748684	8-262149
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252004	126506008	22-405357	7-947574	566	320356	181321496	23-790755	8-271904
253009	127263527	22-427662	7-952848	567	321489	182284263	23-811762	8-276773
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260100	132651000	22-583180	7-989570	574	329476	189119224	23-958297	8-310694
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262144	134217728	22-627417	8-000000	576	331776	191102976	24-000000	8-320335
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266256	137388096	22-715633	8-020779	580	336400	195112000	24-083189	8-339551
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286225	153130375	23-130067	8-118041	599	358801	214921799	24-474477	8-429638
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289444	155720872	23-194827	8-133187	602	362404	218167208	24-535688	8-443688
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291600	157464000	23-237900	8-143253	604	364816	220348864	24-576412	8-453028
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293764	159220088	23-280894	8-153294	606	367236	222545016	24-617067	8-462348
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298116	162771336	23-366643	8-173302	610	372100	226981000	24-698178	8-480926
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304704	168196608	23-494630	8-203132	616	379456	233744896	24-819347	8-508642

No.	Square.	Cube.	Square Root.	Cube Root.	No.	Square.	Cube.	Square Root.	Cube Root.
617	380609	234800110	24-659465	8-513245	681	463761	315821241	26-095977	8-797968
618	381924	236029032	24-859606	8-517840	682	465124	317214568	26-115130	8-802372
619	383161	237176659	24-879711	8-522432	683	466489	318611987	26-134269	8-806572
620	384400	238328000	24-899799	8-527019	684	467856	320013504	26-153394	8-810868
621	385641	239483061	24-919872	8-531601	685	469225	321419125	26-172505	8-815160
622	386884	240641848	24-939926	8-536176	686	470596	322828856	26-191602	8-819447
623	388129	241804367	24-959968	8-540750	687	471969	324242703	26-210685	8-823731
624	389376	242970624	24-979992	8-545317	688	473344	325660672	26-229754	8-828010
625	390625	244146225	25-000000	8-549880	689	474721	327082769	26-248810	8-832286
626	391876	245314376	25-019992	8-554437	690	476100	328509000	26-267851	8-836556
627	393129	246491683	25-039968	8-558990	691	477481	329939371	26-286879	8-840823
628	394384	247678152	25-059928	8-563538	692	478864	331373888	26-305893	8-845088
629	395641	248868189	25-079872	8-568081	693	480249	332812557	26-324893	8-849344
630	396900	2500647000	25-099801	8-572619	694	481636	334255384	26-343880	8-853598
631	398161	251269591	25-119713	8-577152	695	483025	335702375	26-362853	8-857849
632	399424	252483966	25-139610	8-581681	696	484416	337153536	26-381812	8-862098
633	400689	253696137	25-159491	8-586206	697	485809	338608873	26-400758	8-866337
634	401956	254916104	25-179357	8-590724	698	487204	340068392	26-419690	8-870576
635	403225	256047875	25-199206	8-595236	699	488601	341532099	26-438608	8-874810
636	404496	257259456	25-219040	8-599748	700	490000	343000000	26-457513	8-879040
637	405769	258474853	25-238859	8-604252	701	491401	344472101	26-476405	8-883266
638	407044	259694072	25-258662	8-608753	702	492804	345948408	26-495283	8-887488
639	408321	260917119	25-278449	8-613246	703	494209	347428927	26-514147	8-891706
640	409600	262144000	25-298221	8-617739	704	495616	348913664	26-532998	8-895920
641	410881	263374721	25-317978	8-622225	705	497025	350402625	26-551836	8-900130
642	412164	264609268	25-337719	8-626706	706	498436	351895816	26-570661	8-904337
643	413449	265847707	25-357445	8-631183	707	499849	353393243	26-589472	8-908539
644	414736	267089984	25-377155	8-635655	708	501264	354894912	26-608269	8-912737
645	416025	268336125	25-396850	8-640123	709	502681	356400829	26-627054	8-916931
646	417316	269586136	25-416530	8-644583	710	504100	357911000	26-645825	8-921121
647	418609	270840023	25-436195	8-649044	711	505521	359425431	26-664583	8-925308
648	419904	272097792	25-455844	8-653497	712	506944	360944128	26-683328	8-929490
649	421201	273359449	25-475478	8-657946	713	508369	362467097	26-702060	8-933668
650	422500	274625000	25-495098	8-662391	714	509796	363994344	26-720778	8-937843
651	423801	275894451	25-514702	8-666831	715	511225	365525875	26-739484	8-942014
652	425104	277167808	25-534291	8-671266	716	512656	367061696	26-758176	8-946181
653	426409	278445077	25-553865	8-675697	717	514089	368601813	26-776856	8-950344
654	427716	279726264	25-573424	8-680124	718	515524	370146232	26-795522	8-954503
655	429025	281011375	25-592968	8-684546	719	516961	371694959	26-814175	8-958658
656	430336	282300416	25-612497	8-688963	720	518400	373248000	26-832816	8-962809
657	431649	283593393	25-632011	8-693376	721	519841	374805361	26-851443	8-966967
658	432964	284890312	25-651511	8-697784	722	521284	376367048	26-870058	8-971101
659	434281	286191179	25-670995	8-702188	723	522729	377933067	26-888659	8-975241
660	435600	287496000	25-690465	8-706588	724	524176	379503424	26-907248	8-979377
661	436921	288804781	25-709920	8-710983	725	525625	381078125	26-925824	8-983509
662	438244	290117528	25-729361	8-715373	726	527076	382657176	26-944387	8-987637
663	439569	291434247	25-748786	8-719760	727	528529	384240583	26-962938	8-991762
664	440896	292754944	25-768198	8-724141	728	529984	385828352	26-981475	8-995883
665	442225	294079625	25-787594	8-728519	729	531441	387420489	27-000000	9-000000
666	443556	295408296	25-806976	8-732892	730	532900	389017000	27-018512	9-004115
667	444889	296740963	25-826343	8-737260	731	534361	390617891	27-037012	9-008223
668	446224	298077632	25-845696	8-741625	732	535824	392223168	27-055499	9-012323
669	447561	299418300	25-865038	8-745985	733	537289	393833837	27-073973	9-016413
670	448900	300763000	25-884358	8-750340	734	538756	395446904	27-092434	9-020523
671	450241	302111711	25-903668	8-754691	735	540225	397065375	27-110883	9-024624
672	451584	303464448	25-922963	8-759038	736	541696	398688256	27-129320	9-028718
673	452929	304821217	25-942244	8-763381	737	543169	400315553	27-147744	9-032802
674	454276	306182024	25-961510	8-767719	738	544644	401947272	27-166155	9-036886
675	455625	307546875	25-980762	8-772053	739	546121	403583419	27-184554	9-040969
676	456976	308915776	26-000000	8-776383	740	547600	405224000	27-202941	9-045043
677	458329	310288733	26-019224	8-780708	741	549081	406869021	27-221315	9-049114
678	459684	311665752	26-038433	8-785030	742	550564	408518488	27-239677	9-053183
679	461041	313046839	26-057628	8-789347	743	552049	410172407	27-258028	9-057243
680	462400	314432000	26-076810	8-793659	744	553536	411830784	27-276363	9-061303

quare.	Cube.	Square Root.	Cube Root.	No.	Square.	Cube.	Square Root.	Cube Root.
55025	413493625	27-294688	9-065568	309	654481	529475129	28-442925	9-317860
55516	415160936	27-313001	9-069422	310	656100	531441000	28-460499	9-321697
58009	416832723	27-331301	9-073473	311	657721	533411731	28-478062	9-325532
59504	418508992	27-349589	9-077520	312	659344	535387328	28-495614	9-329363
51001	420189749	27-367864	9-081563	313	660969	537367797	28-513155	9-333192
52500	421875000	27-386128	9-085603	314	662596	539353144	28-530685	9-337017
54001	423564751	27-404379	9-089639	315	664225	541343375	28-548205	9-340839
55504	425259008	27-422618	9-093672	316	665856	543338496	28-565714	9-344657
57009	426957777	27-440846	9-097701	317	667489	545338513	28-583212	9-348473
58516	428661064	27-459060	9-101726	318	669124	547343432	28-600699	9-352286
70025	430368875	27-477263	9-105748	319	670761	549353259	28-618176	9-356095
71536	432081216	27-495454	9-109767	320	672400	551368000	28-635642	9-359902
73049	433798093	27-513633	9-113782	321	674041	553387661	28-653098	9-363705
74564	435519512	27-531800	9-117793	322	675684	555412248	28-670542	9-367503
76081	437245479	27-549955	9-121801	323	677329	557441767	28-687977	9-371302
77600	438976000	27-568098	9-125805	324	678976	559476224	28-705400	9-375096
79121	440711081	27-586228	9-129806	325	680625	561515625	28-722813	9-378887
80644	442450728	27-604348	9-133803	326	682276	563559976	28-740216	9-382675
82169	444194947	27-622455	9-137797	327	683929	565609283	28-757608	9-386460
83696	445943744	27-640550	9-141788	328	685584	567663552	28-774989	9-390242
85225	447697125	27-658633	9-145774	329	687241	569722789	28-792360	9-394021
86756	449455096	27-676705	9-149758	330	688900	571787000	28-809721	9-397796
88289	451217663	27-694765	9-153737	331	690561	573856191	28-827071	9-401569
89824	452984832	27-712813	9-157714	332	692224	575930368	28-844410	9-405339
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92900	456533000	27-748874	9-165656	334	695556	580093704	28-879058	9-412869
94441	458314011	27-766887	9-169622	335	697225	582182755	28-896367	9-416630
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99076	463684824	27-820856	9-181500	338	702244	588480472	28-948230	9-427894
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102176	467288576	27-856777	9-189402	340	705600	592704000	28-982754	9-435388
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105284	470910952	27-892651	9-197290	342	708964	596947688	29-017236	9-442870
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114656	481890304	28-000000	9-220873	348	719104	609800192	29-120440	9-465247
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120944	489303872	28-071338	9-236528	352	725904	618470208	29-189039	9-480106
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125681	494913671	28-124722	9-248234	355	731025	625026375	29-240383	9-491220
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130436	500566184	28-178006	9-259911	358	736164	631628712	29-291637	9-502308
132025	502459675	28-195744	9-263797	359	737881	633839779	29-308702	9-505998
133616	504358336	28-213472	9-267680	360	739600	636056000	29-325757	9-509685
135209	506261573	28-231188	9-271559	361	741321	638277381	29-342802	9-513370
136804	508169592	28-248894	9-275435	362	743044	640503928	29-359837	9-517051
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140000	512000000	28-284271	9-283178	364	746496	644972544	29-393877	9-524406
141601	513922401	28-301943	9-287044	365	748225	647214625	29-410882	9-528079
143204	515849608	28-319605	9-290907	366	749956	649461896	29-427878	9-531750
144809	517781627	28-337255	9-294767	367	751689	651714363	29-444864	9-535417
146416	519718464	28-354894	9-298624	368	753424	653972032	29-461840	9-539082
148025	521660125	28-372522	9-302477	369	755161	656234909	29-478806	9-542744
149636	523606616	28-390139	9-306328	370	756900	658503000	29-495762	9-546403
151249	525557943	28-407745	9-310175	371	758641	660776311	29-512709	9-550059
152864	527514112	28-425341	9-314019	372	760384	663054848	29-529646	9-553712

No.	Square.	Cube.	Square Root.	Cube Root.	No.	Square.	Cube.	Square Root.	Cube Root.
873	762129	665330617	29.546073	9.557365	937	877969	822656953	30.610456	9.785429
874	763376	667027624	29.563491	9.561011	938	879844	825293672	30.626786	9.788909
875	765625	669921875	29.580399	9.564656	939	881721	827936019	30.643107	9.792386
876	767376	672221576	29.597297	9.568298	940	883600	830584000	30.659419	9.795861
877	769129	674526133	29.614186	9.571938	941	885481	833237621	30.675723	9.799334
878	770884	676836152	29.631065	9.575574	942	887364	835898888	30.692019	9.802804
879	772641	679151439	29.647934	9.579206	943	889249	838561807	30.708305	9.806271
880	774400	681472000	29.664794	9.582840	944	891136	841232384	30.724583	9.809736
881	776161	683797641	29.681644	9.586466	945	893025	843908625	30.740852	9.813199
882	777924	686126968	29.698485	9.590094	946	894916	846590536	30.757113	9.816659
883	779689	688460387	29.715316	9.593717	947	896809	849278123	30.773365	9.820117
884	781456	690807104	29.732138	9.597337	948	898704	851971732	30.789609	9.823572
885	783225	693158425	29.748950	9.600953	949	900601	854670349	30.805844	9.827025
886	784996	695504556	29.765752	9.604570	950	902500	857375000	30.822070	9.830476
887	786769	697854103	29.782545	9.608182	951	904401	860085351	30.838283	9.833924
888	788544	700227072	29.799329	9.611791	952	906304	862801408	30.854497	9.837369
889	790321	702603569	29.816103	9.615398	953	908209	865523177	30.870698	9.840813
890	792100	704989900	29.832868	9.619002	954	910116	868250664	30.886890	9.844254
891	793881	707384971	29.849623	9.622603	955	912025	870983875	30.903074	9.847692
892	795664	709782288	29.866369	9.626202	956	913936	873722616	30.919250	9.851128
893	797449	712182197	29.883106	9.629797	957	915849	876467493	30.935417	9.854562
894	799236	714583864	29.899833	9.633391	958	917764	879217912	30.951578	9.857993
895	801025	716987575	29.916551	9.636981	959	919681	881974079	30.967725	9.861422
896	802816	719393536	29.933259	9.640569	960	921600	884736000	30.983867	9.864848
897	804609	721801857	29.949958	9.644154	961	923521	887503681	31.000000	9.868272
898	806404	724212672	29.966648	9.647737	962	925444	890277128	31.016125	9.871694
899	808201	726626099	29.983329	9.651317	963	927369	893056347	31.032241	9.875113
900	810000	729040000	30.000000	9.654894	964	929296	895841344	31.048349	9.878530
901	811801	731456401	30.016662	9.658466	965	931225	898632125	31.064449	9.881945
902	813604	733875008	30.033315	9.662040	966	933156	901428696	31.080541	9.885357
903	815409	736295827	30.049958	9.665610	967	935089	904231063	31.096624	9.888767
904	817216	738718264	30.066593	9.669176	968	937024	907039232	31.112698	9.892175
905	819025	741142325	30.083216	9.672740	969	938961	909853209	31.128765	9.895580
906	820836	743567746	30.099834	9.676302	970	940900	912673000	31.144823	9.898983
907	822649	746042643	30.116441	9.679860	971	942841	915496611	31.160873	9.902383
908	824464	748518112	30.133038	9.683417	972	944784	918330048	31.176915	9.905782
909	826281	751094229	30.149627	9.686970	973	946729	921167317	31.192948	9.909178
910	828100	753670400	30.166206	9.690521	974	948676	924010424	31.208973	9.912571
911	829921	756246631	30.182777	9.694069	975	950625	926859375	31.224990	9.915962
912	831744	758822928	30.199338	9.697615	976	952576	929714176	31.240999	9.919351
913	833569	761408497	30.215890	9.701158	977	954529	932574833	31.256999	9.922738
914	835396	764003344	30.232433	9.704699	978	956484	935441352	31.272992	9.926123
915	837225	766600675	30.248967	9.708237	979	958441	938313739	31.288976	9.929504
916	839056	769207526	30.265492	9.711772	980	960400	941192000	31.304952	9.932884
917	840889	771824897	30.282006	9.715305	981	962361	944076141	31.320920	9.936261
918	842724	774452692	30.298515	9.718835	982	964324	946966168	31.336879	9.939636
919	844561	777080921	30.315013	9.722363	983	966289	949862867	31.352831	9.943009
920	846400	779709600	30.331502	9.725888	984	968256	952763904	31.368774	9.946380
921	848241	782338729	30.347982	9.729411	985	970225	955667165	31.384710	9.949748
922	850084	784968304	30.364453	9.732931	986	972196	958585256	31.400637	9.953114
923	851929	787598347	30.380915	9.736448	987	974169	961504803	31.416556	9.956477
924	853776	789828864	30.397366	9.739963	988	976144	964430272	31.432467	9.959839
925	855625	792059857	30.413813	9.743476	989	978121	967361669	31.448370	9.963198
926	857476	794291328	30.430248	9.746986	990	980100	970299900	31.464265	9.966555
927	859329	796523283	30.446675	9.750493	991	982081	973242271	31.480153	9.969909
928	861184	798755724	30.463092	9.753998	992	984064	976191488	31.496032	9.973262
929	863041	801008659	30.479501	9.757500	993	986049	979146657	31.511903	9.976612
930	864900	803262000	30.495901	9.761000	994	988036	982107784	31.527766	9.979960
931	866761	805515841	30.512293	9.764497	995	990025	985074875	31.543621	9.983305
932	868624	807770176	30.528675	9.767992	996	992016	988047936	31.559468	9.986649
933	870489	810025009	30.545049	9.771484	997	994009	991026873	31.575307	9.989990
934	872356	812280344	30.561414	9.774974	998	996004	994011922	31.591138	9.993328
935	874225	814536185	30.577770	9.778462	999	998001	997002999	31.606961	9.996663
936	876096	816792536	30.594117	9.782947					

D.	Arc.	D.	Arc.	D.	Arc.	D.	Arc.	D.	Arc.
1	0174533	61	1-0646508	121	2-1118484	1	2909	1	48
2	0349066	62	1-0821041	122	2-1293017	2	5818	2	97
3	0523599	63	1-0995574	123	2-1467550	3	8727	3	145
4	0698132	64	1-1170107	124	2-1642083	4	11636	4	194
5	0872665	65	1-1344640	125	2-1816616	5	14544	5	242
6	1047198	66	1-1519173	126	2-1991149	6	17453	6	291
7	1221730	67	1-1693706	127	2-2165682	7	20362	7	339
8	1396263	68	1-1868239	128	2-2340214	8	23271	8	388
9	1570796	69	1-2042772	129	2-2514747	9	26180	9	436
10	1745329	70	1-2217305	130	2-2689280	10	29089	10	485
11	1919862	71	1-2391838	131	2-2863813	11	31998	11	533
12	2094395	72	1-2566371	132	2-3038346	12	34907	12	582
13	2268928	73	1-2740904	133	2-3212879	13	37815	13	630
14	2443461	74	1-2915436	134	2-3387412	14	40724	14	679
15	2617994	75	1-3089969	135	2-3561945	15	43633	15	727
16	2792527	76	1-3264502	136	2-3736478	16	46542	16	776
17	2967060	77	1-3439035	137	2-3911011	17	49451	17	824
18	3141593	78	1-3613568	138	2-4085544	18	52360	18	873
19	3316126	79	1-3788101	139	2-4260077	19	55269	19	921
20	3490659	80	1-3962634	140	2-4434610	20	58178	20	970
21	3665191	81	1-4137167	141	2-4609142	21	61087	21	1018
22	3839724	82	1-4311700	142	2-4783675	22	63995	22	1067
23	4014257	83	1-4486233	143	2-4958208	23	66904	23	1115
24	4188790	84	1-4660766	144	2-5132741	24	69813	24	1164
25	4363323	85	1-4835299	145	2-5307274	25	72722	25	1212
26	4537856	86	1-5009832	146	2-5481807	26	75631	26	1261
27	4712389	87	1-5184364	147	2-5656340	27	78540	27	1309
28	4886922	88	1-5358897	148	2-5830873	28	81449	28	1357
29	5061455	89	1-5533430	149	2-6005406	29	84358	29	1406
30	5235988	90	1-5707963	150	2-6179939	30	87266	30	1454
31	5410521	91	1-5882496	151	2-6354472	31	90175	31	1503
32	5585054	92	1-6057029	152	2-6529005	32	93084	32	1551
33	5759587	93	1-6231562	153	2-6703538	33	95993	33	1599
34	5934119	94	1-6406095	154	2-6878070	34	98902	34	1648
35	6108652	95	1-6580628	155	2-7052603	35	101811	35	1697
36	6283185	96	1-6755161	156	2-7227136	36	104720	36	1745
37	6457718	97	1-6929694	157	2-7401669	37	107629	37	1794
38	6632251	98	1-7104227	158	2-7576202	38	110538	38	1842
39	6806784	99	1-7278760	159	2-7750735	39	113446	39	1891
40	6981317	100	1-7453293	160	2-7925268	40	116355	40	1939
41	7155850	101	1-7627826	161	2-8099801	41	119264	41	1988
42	7330383	102	1-7802358	162	2-8274334	42	122173	42	2036
43	7504916	103	1-7976891	163	2-8448867	43	125082	43	2085
44	7679449	104	1-8151424	164	2-8623400	44	127991	44	2133
45	7853982	105	1-8325957	165	2-8797933	45	130900	45	2182
46	8028515	106	1-8500490	166	2-8972466	46	133809	46	2230
47	8203048	107	1-8675023	167	2-9146999	47	136717	47	2279
48	8377581	108	1-8849556	168	2-9321531	48	139626	48	2327
49	8552113	109	1-9024089	169	2-9496064	49	142535	49	2376
50	8726646	110	1-9198622	170	2-9670597	50	145444	50	2424
51	8901179	111	1-9373155	171	2-9845130	51	148353	51	2473
52	9075712	112	1-9547688	172	3-0019663	52	151262	52	2521
53	9250245	113	1-9722220	173	3-0194196	53	154171	53	2570
54	9424778	114	1-9896753	174	3-0368729	54	157080	54	2618
55	9599311	115	2-0071286	175	3-0543262	55	159989	55	2666
56	9773844	116	2-0245819	176	3-0717795	56	162897	56	2715
57	9948377	117	2-0420352	177	3-0892328	57	165806	57	2763
58	1-0122910	118	2-0594885	178	3-1066861	58	168715	58	2812
59	1-0297443	119	2-0769418	179	3-1241394	59	171624	59	2860
60	1-0471976	120	2-0943951	180	3-1415927	60	174533	60	2908

No.	Reciprocals.	No.	Reciprocals.	No.	Reciprocals.	No.	Reciprocals.	No.	Reciprocals.
1	1.000000000	63	015873014	125	008000000	187	005347594	249	004016064
2	500000000	64	015625000	126	007935500	188	005319149	250	004000000
3	333333333	65	015384611	127	007874016	189	005291005	251	003984064
4	250000000	66	015151515	128	007812500	190	005263158	252	003968254
5	200000000	67	014925373	129	007751938	191	005235602	253	003952569
6	166666667	68	014705882	130	007692300	192	005208333	254	003937008
7	142857143	69	014492754	131	007633538	193	005181347	255	003921569
8	125000000	70	014285714	132	007575758	194	005154639	256	003906250
9	111111111	71	014084507	133	007518797	195	005128205	257	003891051
10	100000000	72	013888889	134	007462687	196	005102041	258	003875969
11	090909091	73	013698630	135	007407407	197	005076142	259	003861004
12	083333333	74	013513514	136	007352941	198	005050505	260	003846154
13	076923077	75	013333333	137	007299270	199	005025126	261	003831418
14	071428571	76	013157895	138	007246377	200	005000000	262	003816794
15	066666667	77	012987013	139	007194245	201	004975124	263	003802281
16	062500000	78	012820513	140	007142857	202	004950495	264	003787879
17	058823529	79	012658228	141	007092199	203	004926108	265	003773585
18	055555556	80	012500000	142	007042254	204	004901961	266	003759398
19	052631579	81	012345679	143	006993007	205	004878049	267	003745318
20	050000000	82	012195122	144	006944444	206	004854369	268	003731343
21	047619048	83	012048195	145	006896552	207	004830918	269	003717472
22	045454545	84	011904762	146	006849315	208	004807692	270	003703704
23	043478261	85	011764706	147	006802721	209	004784639	271	003689037
24	041666667	86	011627907	148	006756757	210	004761905	272	003674671
25	040000000	87	011494253	149	006711409	211	004739336	273	003660304
26	038461538	88	011363636	150	006666667	212	004716981	274	003646935
27	037037037	89	011235955	151	006622517	213	004694836	275	003633634
28	035714286	90	011111111	152	006578947	214	004672897	276	003620388
29	034482759	91	010989011	153	006535948	215	004651163	277	003607108
30	033333333	92	010869563	154	006493506	216	004629630	278	003593722
31	032258065	93	010752638	155	006451613	217	004608295	279	003580429
32	031250000	94	010638298	156	006410256	218	004587156	280	003567149
33	030303030	95	010526316	157	006369427	219	004566210	281	003553822
34	029411765	96	010416667	158	006329114	220	004545455	282	003540699
35	028571429	97	010309278	159	006289308	221	004524887	283	003527659
36	027777778	98	010204082	160	006250000	222	004504505	284	003514127
37	027027027	99	010101010	161	006211180	223	004484305	285	003500872
38	026315789	100	010000000	162	006172840	224	004464286	286	003487653
39	025641026	101	009900990	163	006134969	225	004444444	287	003474321
40	025000000	102	009803922	164	006097561	226	004424279	288	003461000
41	024390244	103	009708738	165	006060606	227	004405286	289	003447688
42	023809524	104	009615385	166	006024096	228	004385965	290	003434376
43	023255814	105	009523810	167	005988024	229	004366812	291	003421064
44	022727273	106	009433962	168	005952381	230	004347826	292	003407752
45	022222222	107	009345794	169	005917160	231	004329004	293	003394440
46	021739130	108	009259259	170	005882353	232	004310345	294	003381128
47	021276600	109	009174312	171	005847953	233	004291845	295	003367816
48	020833333	110	009090909	172	005813953	234	004273504	296	003354504
49	020408163	111	009009009	173	005780347	235	004255319	297	003341192
50	020000000	112	008928571	174	005747126	236	004237288	298	003327880
51	019607843	113	008849555	175	005714286	237	004219409	299	003314568
52	019230769	114	008771930	176	005681818	238	004201681	300	003301256
53	018867923	115	008695652	177	005649718	239	004184100	301	003287944
54	018518519	116	008620690	178	005617978	240	004166667	302	003274632
55	018181818	117	008547009	179	005586592	241	004149378	303	003261320
56	017857143	118	008474576	180	005555556	242	004132231	304	003248008
57	017543860	119	008403361	181	005524462	243	004115226	305	003234696
58	017241379	120	008333333	182	005494505	244	004098361	306	003221384
59	016949153	121	008264463	183	005464481	245	004081633	307	003208072
60	016666667	122	008196721	184	005434783	246	004065041	308	003194760
61	016393443	123	008130081	185	005405405	247	004048383	309	003181448
62	016129032	124	008064516	186	005376344	248	004032258	310	003168136

No.	Reciprocal.	No.	Reciprocal.	No.	Reciprocal.	No.	Reciprocal.	No.	Reciprocal.
311	.003215434	349	.002865336	387	.002583979	425	.002352941	463	.002159827
312	.003205128	350	.002857143	388	.002577320	426	.002347418	464	.002155172
313	.003194888	351	.002849003	389	.002570694	427	.002341920	465	.002150538
314	.003184713	352	.002840909	390	.002564103	428	.002336449	466	.002145923
315	.003174603	353	.002832861	391	.002557545	429	.002331002	467	.002141328
316	.003164557	354	.002824859	392	.002551020	430	.002325581	468	.002136752
317	.003154574	355	.002816901	393	.002544529	431	.002320186	469	.002132196
318	.003144654	356	.002808989	394	.002538071	432	.002314815	470	.002127660
319	.003134796	357	.002801120	395	.002531646	433	.002309469	471	.002123142
320	.003125000	358	.002793296	396	.002525253	434	.002304147	472	.002118644
321	.003115265	359	.002785515	397	.002518892	435	.002298851	473	.002114165
322	.003105590	360	.002777778	398	.002512563	436	.002293578	474	.002109705
323	.003095975	361	.002770083	399	.002506260	437	.002288330	475	.002105263
324	.003086420	362	.002762431	400	.002500000	438	.002283105	476	.002100840
325	.003076923	363	.002754821	401	.002493766	439	.002277904	477	.002096436
326	.003067485	364	.002747253	402	.002487562	440	.002272727	478	.002092050
327	.003058104	365	.002739726	403	.002481390	441	.002267574	479	.002087683
328	.003048780	366	.002732240	404	.002475248	442	.002262443	480	.002083333
329	.003039514	367	.002724796	405	.002469136	443	.002257336	481	.002079002
330	.003030303	368	.002717391	406	.002463054	444	.002252252	482	.002074689
331	.003021148	369	.002710027	407	.002457002	445	.002247191	483	.002070393
332	.003012048	370	.002702703	408	.002450980	446	.002242152	484	.002066116
333	.003003003	371	.002695418	409	.002444988	447	.002237136	485	.002061856
334	.002994012	372	.002688172	410	.002439024	448	.002232143	486	.002057613
335	.002985076	373	.002680966	411	.002433090	449	.002227171	487	.002053388
336	.002976190	374	.002673797	412	.002427184	450	.002222222	488	.002049180
337	.002967359	375	.002666667	413	.002421308	451	.002217295	489	.002044990
338	.002958580	376	.002659574	414	.002415459	452	.002212389	490	.002040816
339	.002949853	377	.002652520	415	.002409639	453	.002207506	491	.002036660
340	.002941176	378	.002645503	416	.002403846	454	.002202643	492	.002032520
341	.002932551	379	.002638522	417	.002398082	455	.002197802	493	.002028398
342	.002923977	380	.002631579	418	.002392344	456	.002192982	494	.002024291
343	.002915452	381	.002624672	419	.002386635	457	.002188184	495	.002020202
344	.002906977	382	.002617801	420	.002380952	458	.002183406	496	.002016129
345	.002898551	383	.002611060	421	.002375297	459	.002178649	497	.002012072
346	.002890173	384	.002604167	422	.002369668	460	.002173913	498	.002008032
347	.002881844	385	.002597403	423	.002364066	461	.002169197	499	.002004008
348	.002873563	386	.002590674	424	.002358491	462	.002164502	500	.002000000

LOGARITHMS TO SEVEN PLACES FOR QUESTIONS IN INTEREST, &c.

Num.	Log.	Num.	Log.	Num.	Log.	Num.	Log.	Num.	Log.
1.001	.0004341	1.021	.0090257	1.041	.0174507	1.061	.0257154	1.081	.0336257
1.002	.0008677	1.022	.0094509	1.042	.0178677	1.062	.0261245	1.082	.0342273
1.003	.0013009	1.023	.0098756	1.043	.0182843	1.063	.0265333	1.083	.0348285
1.004	.0017337	1.024	.0103000	1.044	.0187005	1.064	.0269416	1.084	.0354293
1.005	.0021661	1.025	.0107239	1.045	.0191163	1.065	.0273496	1.085	.0360297
1.006	.0025990	1.026	.0111474	1.046	.0195317	1.066	.0277572	1.086	.0366298
1.007	.0030325	1.027	.0115704	1.047	.0199467	1.067	.0281644	1.087	.0372295
1.008	.0034650	1.028	.0119931	1.048	.0203613	1.068	.0285713	1.088	.0378289
1.009	.0038971	1.029	.0124154	1.049	.0207755	1.069	.0289777	1.089	.0384279
1.010	.0043214	1.030	.0128372	1.050	.0211893	1.070	.0293838	1.090	.0390265
1.011	.0047512	1.031	.0132587	1.051	.0216027	1.071	.0297895	1.091	.0396248
1.012	.0051805	1.032	.0136797	1.052	.0220157	1.072	.0301948	1.092	.0402226
1.013	.0056094	1.033	.0141003	1.053	.0224284	1.073	.0305997	1.093	.0408202
1.014	.0060380	1.034	.0145205	1.054	.0228406	1.074	.0310043	1.094	.0414173
1.015	.0064660	1.035	.0149403	1.055	.0232525	1.075	.0314085	1.095	.0420141
1.016	.0068937	1.036	.0153598	1.056	.0236639	1.076	.0318123	1.096	.0426106
1.017	.0073210	1.037	.0157788	1.057	.0240750	1.077	.0322157	1.097	.0432066
1.018	.0077478	1.038	.0161974	1.058	.0244857	1.078	.0326188	1.098	.0438023
1.019	.0081742	1.039	.0166155	1.059	.0248960	1.079	.0330214	1.099	.0443977
1.020	.0086002	1.040	.0170333	1.060	.0253059	1.080	.0334236	1.100	.0449927

Cour.	Dist. 1.		Dist. 2.		Dist. 3.		Dist. 4.		Dist. 5.		Cour.	
Pt. D.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Pt. D.	
0 1/4	1	0.9998	0.0174	1.9997	0.0349	2.9995	0.0524	3.9994	0.0698	4.9992	0.0873	89
	2	0.9994	0.0349	1.9993	0.0698	2.9982	0.1047	3.9976	0.1396	4.9970	0.1745	88
	3	0.9988	0.0491	1.9976	0.0981	2.9964	0.1472	3.9952	0.1963	4.9940	0.2453	73
	4	0.9986	0.0523	1.9973	0.1047	2.9959	0.1570	3.9945	0.2093	4.9931	0.2617	87
	5	0.9976	0.0698	1.9951	0.1395	2.9927	0.2093	3.9903	0.2790	4.9878	0.3488	86
0 1/2	6	0.9962	0.0872	1.9924	0.1743	2.9886	0.2615	3.9848	0.3486	4.9810	0.4358	85
	7	0.9952	0.0980	1.9904	0.1960	2.9856	0.2941	3.9807	0.3921	4.9759	0.4901	74
	8	0.9945	0.1045	1.9890	0.2091	2.9836	0.3136	3.9781	0.4181	4.9726	0.5226	84
	9	0.9925	0.1219	1.9851	0.2437	2.9776	0.3656	3.9702	0.4875	4.9627	0.6093	83
	10	0.9903	0.1392	1.9805	0.2783	2.9708	0.4175	3.9611	0.5567	4.9513	0.6959	82
0 3/4	11	0.9892	0.1467	1.9784	0.2935	2.9675	0.4402	3.9567	0.5869	4.9459	0.7337	71
	12	0.9877	0.1564	1.9754	0.3129	2.9631	0.4693	3.9508	0.6257	4.9384	0.7822	81
	13	0.9848	0.1736	1.9696	0.3473	2.9544	0.5209	3.9392	0.6946	4.9240	0.8682	80
	14	0.9816	0.1908	1.9633	0.3816	2.9449	0.5724	3.9265	0.7632	4.9081	0.9540	79
	15	0.9808	0.1951	1.9616	0.3902	2.9424	0.5853	3.9231	0.7804	4.9039	0.9755	7
1	16	0.9781	0.2079	1.9563	0.4158	2.9344	0.6237	3.9126	0.8316	4.8907	1.0396	78
	17	0.9744	0.2250	1.9487	0.4499	2.9231	0.6749	3.8975	0.8998	4.8719	1.1248	77
	18	0.9703	0.2419	1.9406	0.4838	2.9109	0.7258	3.8812	0.9677	4.8515	1.2096	76
	19	0.9700	0.2430	1.9401	0.4860	2.9101	0.7289	3.8801	0.9719	4.8502	1.2149	62
	20	0.9659	0.2588	1.9319	0.5176	2.8978	0.7765	3.8637	1.0353	4.8296	1.2941	75
1 1/4	21	0.9613	0.2756	1.9225	0.5513	2.8838	0.8269	3.8450	1.1025	4.8063	1.3782	74
	22	0.9569	0.2903	1.9139	0.5806	2.8708	0.8709	3.8278	1.1611	4.7847	1.4514	61
	23	0.9563	0.2924	1.9126	0.5847	2.8689	0.8771	3.8252	1.1695	4.7815	1.4619	73
	24	0.9511	0.3090	1.9021	0.6180	2.8532	0.9271	3.8042	1.2361	4.7553	1.5451	72
	25	0.9455	0.3256	1.8910	0.6511	2.8366	0.9767	3.7821	1.3023	4.7276	1.6278	71
1 1/2	26	0.9415	0.3369	1.8831	0.6738	2.8246	1.0107	3.7662	1.3476	4.7077	1.6844	62
	27	0.9397	0.3420	1.8794	0.6840	2.8191	1.0261	3.7588	1.3681	4.6985	1.7101	70
	28	0.9336	0.3584	1.8672	0.7167	2.8007	1.0751	3.7343	1.4335	4.6679	1.7918	69
	29	0.9272	0.3746	1.8544	0.7492	2.7816	1.1238	3.7087	1.4984	4.6359	1.8730	68
	30	0.9239	0.3827	1.8478	0.7654	2.7716	1.1481	3.6955	1.5307	4.6194	1.9134	6
2	31	0.9205	0.3907	1.8410	0.7815	2.7615	1.1722	3.6820	1.5629	4.6025	1.9537	67
	32	0.9135	0.4067	1.8271	0.8135	2.7406	1.2202	3.6542	1.6269	4.5677	2.0337	66
	33	0.9063	0.4226	1.8126	0.8452	2.7189	1.2679	3.6252	1.6905	4.5315	2.1131	65
	34	0.9040	0.4276	1.8080	0.8551	2.7120	1.2827	3.6160	1.7102	4.5199	2.1378	53
	35	0.8988	0.4384	1.7976	0.8767	2.6964	1.3151	3.5952	1.7535	4.4940	2.1919	64
2 1/4	36	0.8910	0.4540	1.7820	0.9080	2.6730	1.3620	3.5640	1.8160	4.4550	2.2700	63
	37	0.8829	0.4695	1.7659	0.9389	2.6488	1.4084	3.5318	1.8779	4.4147	2.3474	62
	38	0.8819	0.4714	1.7638	0.9428	2.6458	1.4142	3.5277	1.8856	4.4096	2.3570	51
	39	0.8746	0.4848	1.7492	0.9696	2.6239	1.4544	3.4985	1.9392	4.3731	2.4240	60
	40	0.8660	0.5000	1.7321	1.0000	2.5981	1.5000	3.4641	2.0000	4.3301	2.5000	60
2 1/2	41	0.8577	0.5141	1.7155	1.0282	2.5732	1.5423	3.4309	2.0564	4.2886	2.5705	52
	42	0.8572	0.5150	1.7143	1.0301	2.5715	1.5451	3.4287	2.0602	4.2858	2.5752	59
	43	0.8480	0.5299	1.6961	1.0593	2.5441	1.5898	3.3922	2.1197	4.2402	2.6496	58
	44	0.8387	0.5446	1.6773	1.0893	2.5160	1.6339	3.3547	2.1786	4.1934	2.7232	57
	45	0.8315	0.5556	1.6629	1.1111	2.4944	1.6667	3.3259	2.2223	4.1573	2.7779	5
3	46	0.8290	0.5592	1.6581	1.1184	2.4871	1.6776	3.3162	2.2368	4.1452	2.7960	56
	47	0.8192	0.5736	1.6383	1.1472	2.4575	1.7207	3.2766	2.2943	4.0958	2.8679	55
	48	0.8090	0.5878	1.6180	1.1756	2.4271	1.7634	3.2361	2.3511	4.0451	2.9389	54
	49	0.8032	0.5957	1.6064	1.1914	2.4096	1.7871	3.2128	2.3828	4.0160	2.9785	43
	50	0.7986	0.6018	1.5973	1.2036	2.3959	1.8054	3.1945	2.4073	3.9932	3.0091	53
3 1/4	51	0.7880	0.6157	1.5760	1.2313	2.3640	1.8470	3.1520	2.4626	3.9401	3.0783	52
	52	0.7771	0.6293	1.5543	1.2586	2.3314	1.8880	3.1086	2.5173	3.8857	3.1466	51
	53	0.7730	0.6344	1.5460	1.2688	2.3190	1.9032	3.0920	2.5376	3.8650	3.1720	41
	54	0.7660	0.6428	1.5321	1.2856	2.2981	1.9284	3.0642	2.5712	3.8302	3.2139	50
	55	0.7547	0.6561	1.5094	1.3121	2.2641	1.9682	3.0188	2.6242	3.7735	3.2803	49
3 1/2	56	0.7431	0.6691	1.4803	1.3383	2.2294	2.0074	2.9726	2.6765	3.7157	3.3457	48
	57	0.7410	0.6716	1.4819	1.3431	2.2229	2.0147	2.9638	2.6862	3.7048	3.3571	42
	58	0.7314	0.6820	1.4627	1.3640	2.1941	2.0460	2.9254	2.7280	3.6568	3.4100	47
	59	0.7193	0.6947	1.4387	1.3893	2.1580	2.0840	2.8774	2.7786	3.5967	3.4733	46
	60	0.7071	0.7071	1.4142	1.4142	2.1213	2.1213	2.8284	2.8284	3.5355	3.5355	45
Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	
Dist. 1.		Dist. 2.		Dist. 3.		Dist. 4.		Dist. 5.		Dist. 5.		

TABLE OF DIFFERENCE OF LATITUDE AND DEPARTURE.

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Cour.	Dist. 6.		Dist. 7.		Dist. 8.		Dist. 9.		Dist. 10.		Cour.																																																
	Pt. D.	Lat. Dep.	Lat. Dep.	Lat. Dep.	Lat. Dep.	Lat. Dep.	Lat. Dep.	Lat. Dep.	Pt. D.																																																		
0 1/2	1	5-9991 0-1047	6-9989 0-1222	7-9988 0-1396	8-9986 0-1571	9-9985 0-1745	89																																																				
	2	5-9963 0-2094	6-9957 0-2443	7-9951 0-2792	8-9945 0-3141	9-9939 0-3490	88																																																				
	3	5-9928 0-2944	6-9916 0-3435	7-9904 0-3925	8-9892 0-4416	9-9880 0-4907	87																																																				
	4	5-9918 0-3140	6-9904 0-3664	7-9890 0-4187	8-9877 0-4710	9-9863 0-5234	86																																																				
	5	5-9854 0-4185	6-9829 0-4883	7-9805 0-5581	8-9781 0-6278	9-9756 0-6976	85																																																				
0 1/2	6	5-9772 0-5229	6-9734 0-6101	7-9696 0-6972	8-9658 0-7844	9-9619 0-8716	84																																																				
	7	5-9711 0-5881	6-9663 0-6861	7-9615 0-7841	8-9567 0-8822	9-9518 0-9802	83																																																				
	8	5-9671 0-6272	6-9617 0-7317	7-9562 0-8362	8-9507 0-9408	9-9452 1-0453	82																																																				
	9	5-9553 0-7312	6-9478 0-8531	7-9404 0-9750	8-9329 1-0968	9-9255 1-2187	81																																																				
	10	5-9416 0-8350	6-9319 0-9742	7-9221 1-1134	8-9124 1-2526	9-9027 1-3917	80																																																				
1	11	5-9351 0-8804	6-9242 1-0271	7-9134 1-1738	8-9026 1-3206	9-8918 1-4673	79																																																				
	12	5-9261 0-9386	6-9138 1-0950	7-9015 1-2515	8-8892 1-4079	9-8769 1-5643	78																																																				
	13	5-9088 1-0419	6-8937 1-2155	7-8785 1-3892	8-8633 1-5628	9-8481 1-7365	77																																																				
	14	5-8898 1-1449	6-8714 1-3357	7-8530 1-5265	8-8346 1-7173	9-8163 1-9081	76																																																				
	15	5-8847 1-1705	6-8655 1-3656	7-8463 1-5607	8-8271 1-7558	9-8079 1-9509	75																																																				
1 1/2	16	5-8689 1-2475	6-8470 1-4554	7-8252 1-6633	8-8033 1-8712	9-7815 2-0791	74																																																				
	17	5-8462 1-3497	6-8206 1-5747	7-7950 1-7996	8-7693 2-0246	9-7437 2-2495	73																																																				
	18	5-8218 1-4515	6-7921 1-6935	7-7624 1-9354	8-7327 2-1773	9-7030 2-4192	72																																																				
	19	5-8202 1-4579	6-7902 1-7009	7-7602 1-9438	8-7303 2-1868	9-7003 2-4298	71																																																				
	20	5-7956 1-5529	6-7615 1-8117	7-7274 2-0706	8-6933 2-3294	9-6593 2-5882	70																																																				
2	21	5-7676 1-6533	6-7288 1-9295	7-6901 2-2051	8-6513 2-4807	9-6120 2-7562	69																																																				
	22	5-7416 1-7417	6-6986 2-0320	7-6555 2-3223	8-6125 2-6126	9-5694 2-9028	68																																																				
	23	5-7378 1-7542	6-6941 2-0466	7-6504 2-3390	8-6067 2-6313	9-5630 2-9237	67																																																				
	24	5-7063 1-8541	6-6574 2-1631	7-6085 2-4721	8-5595 2-7812	9-5106 3-0902	66																																																				
	25	5-6731 1-9534	6-6186 2-2790	7-5642 2-6045	8-5097 2-9301	9-4552 3-2557	65																																																				
2 1/2	26	5-6493 2-0213	6-5908 2-3582	7-5324 2-6951	8-4739 3-0320	9-4154 3-3689	64																																																				
	27	5-6382 2-0521	6-5778 2-3941	7-5175 2-7362	8-4572 3-0782	9-3969 3-4202	63																																																				
	28	5-6015 2-1502	6-5351 2-5086	7-4686 2-8669	8-4022 3-2253	9-3358 3-5837	62																																																				
	29	5-5631 2-2476	6-4903 2-6222	7-4175 2-9969	8-3447 3-3715	9-2718 3-7461	61																																																				
	30	5-5433 2-2961	6-4672 2-6783	7-3910 3-0615	8-3149 3-4442	9-2388 3-8268	60																																																				
3	31	5-5230 2-3444	6-4435 2-7351	7-3640 3-1258	8-2845 3-5166	9-2050 3-9073	59																																																				
	32	5-4813 2-4404	6-3948 2-8472	7-3084 3-2539	8-2219 3-6606	9-1355 4-0674	58																																																				
	33	5-4378 2-5357	6-3442 2-9583	7-2505 3-3809	8-1568 3-8036	9-0631 4-2262	57																																																				
	34	5-4239 2-5653	6-3279 2-9929	7-2319 3-4204	8-1359 3-8480	9-0399 4-2756	56																																																				
	35	5-3928 2-6302	6-2916 3-0686	7-1904 3-5070	8-0891 3-9453	9-9879 4-3837	55																																																				
3 1/2	36	5-3460 2-7239	6-2370 3-1779	7-1280 3-6319	8-0191 4-0859	9-9101 4-5399	54																																																				
	37	5-2977 2-8168	6-1806 3-2863	7-0636 3-7558	7-9465 4-2252	8-8295 4-6947	53																																																				
	38	5-2915 2-8284	6-1734 3-2998	7-0554 7-7112	7-9373 4-2426	8-8192 4-7140	52																																																				
	39	5-2477 2-9089	6-1223 3-3937	6-9970 3-8785	7-8716 4-3633	8-7462 4-8481	51																																																				
	40	5-1962 3-0000	6-0622 3-5000	6-9282 4-0000	7-7942 4-5000	8-6603 5-0000	50																																																				
4	41	5-1464 3-0846	6-0041 3-5987	6-8618 4-1128	7-7196 4-6269	8-5773 5-1410	49																																																				
	42	5-1430 3-0902	6-0002 3-6053	6-8573 4-1203	7-7145 4-6353	8-5717 5-1504	48																																																				
	43	5-0883 3-1795	5-9363 3-7094	6-7844 4-2394	7-6324 4-7093	8-4805 5-2992	47																																																				
	44	5-0320 3-2678	5-8707 3-8125	6-7094 4-3571	7-5480 4-9018	8-3867 5-4464	46																																																				
	45	4-9888 3-3334	5-8203 3-8890	6-6518 4-4446	7-4832 5-0001	8-3147 5-5557	45																																																				
4 1/2	46	4-9742 3-3552	5-8033 3-9144	6-6323 4-4735	7-4613 5-0327	8-2904 5-5919	44																																																				
	47	4-9149 3-4415	5-7341 4-0150	6-5532 4-5836	7-3724 5-1622	8-1915 5-7358	43																																																				
	48	4-8541 3-5267	5-6631 4-1145	6-4721 4-7023	7-2812 5-2901	8-0902 5-8779	42																																																				
	49	4-8192 3-5742	5-6225 4-1699	6-4257 4-7656	7-2289 5-3613	8-0321 5-9570	41																																																				
	50	4-7918 3-6109	5-5904 4-2127	6-3891 4-8145	7-1877 5-4163	7-9864 6-0182	40																																																				
5	51	4-7281 3-6940	5-5161 4-3096	6-3041 4-9253	7-0921 5-5409	7-8801 6-1566	39																																																				
	52	4-6629 3-7759	5-4400 4-4052	6-2172 5-0346	6-9943 5-6639	7-7715 6-2932	38																																																				
	53	4-6381 3-8064	5-4111 4-4408	6-1841 5-0751	6-9571 5-7095	7-7301 6-3439	37																																																				
	54	4-5963 3-8567	5-3623 4-4995	6-1284 5-1423	6-8944 5-7851	7-6604 6-4279	36																																																				
	55	4-5283 3-9363	5-2830 4-5924	6-0377 5-2485	6-7924 5-9045	7-5471 6-5006	35																																																				
5 1/2	56	4-4589 4-0148	5-2020 4-6839	5-9452 5-3530	6-6883 6-0222	7-4314 6-6913	34																																																				
	57	4-4437 4-0294	5-1867 4-7009	5-9276 5-3725	6-6686 6-0440	7-4095 6-7156	33																																																				
	58	4-3881 4-0920	5-1195 4-7740	5-8508 5-4560	6-5822 6-1380	7-3135 6-8200	32																																																				
	59	4-3160 4-1680	5-0354 4-8626	5-7547 5-5573	6-4741 6-2519	7-1934 6-9486	31																																																				
	60	4-2426 4-2426	4-9497 4-9497	5-6569 5-6569	6-3640 6-3640	7-0711 7-0711	30																																																				
Pt. D.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Pt. D.																																															
Dist. 6.												Dist. 7.												Dist. 8.												Dist. 9.												Dist. 10.											

TABLE OF REFRACTIONS.

App. Altitude.	Refr. B. 30 Th. 50°	Diff. for 1' Alt.	Diff. for + 1 B.	Diff. for - 1° Fa.	App. Altitude.	Refr. B. 30 Th. 50°	Diff. for 1' Alt.	Diff. for + 1 B.	Diff. for - 1° Fa.
D. M.	M. S.	S.	S.	S.	D. M.	M. S.	S.	S.	S.
0 0	33 51	11·7	74	8·1	4 0	11 52	2·2	24·1	1·70
5	32 53	11·3	71	7·6	10	11 30	2·1	23·4	1·64
10	31 58	10·9	69	7·3	20	11 10	2·0	22·7	1·58
15	31 5	10·5	67	7·0	30	10 50	1·9	22·0	1·53
20	30 13	10·1	65	6·7	40	10 32	1·8	21·3	1·48
25	29 24	9·7	63	6·4	50	10 15	1·7	20·7	1·43
30	28 37	9·4	61	6·1	5 0	9 58	1·6	20·1	1·38
35	27 51	9·0	59	5·9	10	9 42	1·5	19·6	1·34
40	27 6	8·7	58	5·6	20	9 27	1·5	19·1	1·30
45	26 24	8·4	56	5·4	30	9 11	1·4	18·6	1·26
50	25 43	8·0	55	5·1	40	8 58	1·3	18·1	1·22
55	25 3	7·7	53	4·9	50	8 45	1·3	17·6	1·19
1 0	24 25	7·4	52	4·7	6 0	8 32	1·2	17·2	1·15
5	23 48	7·1	50	4·6	10	8 20	1·2	16·8	1·11
10	23 13	6·9	49	4·5	20	8 9	1·1	16·4	1·09
15	22 40	6·6	48	4·4	30	7 58	1·1	16·0	1·06
20	22 8	6·3	46	4·2	40	7 47	1·0	15·7	1·03
25	21 37	6·1	45	4·0	50	7 37	1·0	15·3	1·00
30	21 7	5·9	44	3·9	7 0	7 27	1·0	15·0	·98
35	20 38	5·7	43	3·8	10	7 17	·9	14·6	·95
40	20 10	5·5	42	3·6	20	7 8	·9	14·3	·93
45	19 43	5·3	40	3·5	30	6 59	·8	14·1	·91
50	19 17	5·1	39	3·4	40	6 51	·8	13·8	·89
55	18 52	4·9	39	3·3	50	6 43	·8	13·5	·87
2 0	18 29	4·8	38	3·2	8 0	6 35	·7	13·3	·85
5	18 5	4·6	37	3·1	10	6 28	·7	13·1	·83
10	17 43	4·4	36	3·0	20	6 21	·7	12·8	·82
15	17 21	4·3	36	2·9	30	6 14	·7	12·6	·80
20	17 0	4·1	35	2·8	40	6 7	·7	12·3	·79
25	16 40	4·0	34	2·8	50	6 0	·6	12·1	·77
30	16 21	3·9	33	2·7	9 0	5 54	·6	11·9	·76
35	16 2	3·7	33	2·7	10	5 47	·6	11·7	·74
40	15 43	3·6	32	2·6	20	5 41	·6	11·5	·73
45	15 25	3·5	32	2·5	30	5 36	·6	11·3	·71
50	15 8	3·4	31	2·4	40	5 30	·5	11·1	·71
55	14 51	3·3	30	2·3	50	5 25	·5	11·0	·70
3 0	14 35	3·2	30	2·3	10 0	5 20	·5	10·8	·69
5	14 19	3·1	29	2·2	10	5 15	·5	10·6	·67
10	14 4	3·0	29	2·2	20	5 10	·5	10·4	·65
15	13 50	2·9	28	2·1	30	5 5	·5	10·2	·64
20	13 35	2·8	28	2·1	40	5 0	·5	10·1	·63
25	13 21	2·7	27	2·0	50	4 56	·4	9·9	·62
30	13 7	2·7	27	2·0	11 0	4 51	·4	9·8	·60
35	12 53	2·6	26	2·0	10	4 47	·4	9·6	·59
40	12 41	2·5	26	1·9	20	4 43	·4	9·5	·58
45	12 28	2·4	25	1·9	30	4 39	·4	9·4	·57
50	12 16	2·4	25	1·9	40	4 35	·4	9·2	·56
55	12 3	2·3	25	1·8	50	4 31	·4	9·1	·55

TABLE OF REFRACTIONS.

App. Altitude.	Refr. B. 30 Th. 50°	Diff. for 1' Alt.	Diff. for + 1 B.	Diff. for - 1° Fa.	App. Altitude.	Refr. B. 30 Th. 50°	Diff. for 1' Alt.	Diff. for + 1 B.	Diff. for - 1° Fa.
D. M.	M. S.	S.	S.	S.	D.	M. S.	S.	S.	S.
12 0	4 28.1	.38	9.00	.506	42	1 4.6	.038	2.16	.130
10	4 21.4	.37	8.86	.548	43	1 2.4	.036	2.09	.125
20	4 20.8	.36	8.74	.541	44	1 0.3	.034	2.02	.120
30	4 17.3	.35	8.63	.533	45	58.1	.034	1.94	.117
40	4 13.9	.33	8.51	.524	46	56.1	.033	1.88	.112
50	4 10.7	.32	8.41	.517	47	54.2	.032	1.81	.108
13 0	4 7.5	.31	8.30	.509	48	52.3	.031	1.75	.104
10	4 4.4	.31	8.20	.503	49	50.5	.030	1.69	.101
20	4 1.4	.30	8.10	.496	50	48.8	.029	1.63	.097
30	3 58.4	.30	8.00	.490	51	47.1	.028	1.58	.094
40	3 55.5	.29	7.89	.482	52	45.4	.027	1.52	.090
50	3 52.6	.29	7.79	.476	53	43.8	.026	1.47	.088
14 0	3 49.9	.28	7.70	.469	54	42.2	.026	1.41	.085
10	3 47.1	.28	7.61	.464	55	40.8	.025	1.36	.082
20	3 44.4	.27	7.52	.458	56	39.3	.025	1.31	.079
30	3 41.8	.26	7.43	.453	57	37.8	.025	1.26	.076
40	3 39.2	.26	7.34	.448	58	36.4	.024	1.22	.073
50	3 36.7	.25	7.26	.444	59	35.0	.024	1.17	.070
15 0	3 34.3	.24	7.18	.439	60	33.6	.023	1.12	.067
30	3 27.3	.22	6.95	.424	61	32.3	.022	1.08	.065
16 0	3 20.6	.21	6.73	.411	62	31.0	.022	1.04	.062
30	3 14.4	.20	6.51	.399	63	29.7	.021	.99	.060
17 0	3 8.5	.19	6.31	.386	64	28.4	.021	.95	.057
30	3 2.9	.18	6.12	.374	65	27.2	.020	.91	.055
18 0	2 57.6	.17	5.98	.362	66	25.9	.020	.87	.052
19 0	2 47.7	.16	5.61	.340	67	24.7	.020	.83	.050
20	2 38.7	.15	5.31	.322	68	23.5	.020	.79	.047
21	2 30.5	.13	5.04	.305	69	22.4	.020	.75	.045
22	2 23.2	.12	4.79	.290	70	21.2	.020	.71	.043
23	2 16.5	.11	4.67	.276	71	19.9	.020	.67	.040
24	2 10.1	.10	4.35	.264	72	18.8	.019	.63	.038
25	2 4.2	.09	4.16	.252	73	17.7	.018	.59	.036
26	1 58.8	.09	3.97	.241	74	16.6	.018	.56	.033
27	1 53.8	.08	3.81	.230	75	15.5	.018	.52	.031
28	1 49.1	.08	3.65	.219	76	14.4	.018	.48	.029
29	1 44.7	.07	3.50	.209	77	13.4	.017	.45	.027
30	1 40.5	.07	3.36	.201	78	12.3	.017	.41	.025
31	1 36.6	.06	3.23	.193	79	11.2	.017	.38	.023
32	1 33.0	.06	3.11	.186	80	10.2	.017	.34	.021
33	1 29.5	.06	2.99	.179	81	9.2	.017	.31	.018
34	1 26.1	.05	2.88	.173	82	8.2	.017	.27	.016
35	1 23.0	.05	2.78	.167	83	7.1	.017	.24	.014
36	1 20.0	.05	2.68	.161	84	6.1	.017	.20	.012
37	1 17.1	.05	2.58	.155	85	5.1	.017	.17	.010
38	1 14.4	.05	2.49	.149	86	4.1	.017	.14	.008
39	1 11.8	.04	2.40	.144	87	3.1	.017	.10	.006
40	1 9.3	.04	2.32	.139	88	2.0	.017	.07	.004
41	1 6.9	.04	2.24	.134	89	1.0	.017	.03	.002

TABLE FOR REDUCING LONGITUDE INTO TIME, AND THE CONTRARY.

°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.
'	m. s.	'	m. s.	'	m. s.	'	m. s.	'	m. s.	'	m. s.
"	s. t.	"	s. t.	"	s. t.	"	s. t.	"	s. t.	"	s. t.
1	0 4	31	2 4	61	4 4	91	6 4	121	8 4	151	10 4
2	0 8	32	2 8	62	4 8	92	6 8	122	8 8	152	10 8
3	0 12	33	2 12	63	4 12	93	6 12	123	8 12	153	10 12
4	0 16	34	2 16	64	4 16	94	6 16	124	8 16	154	10 16
5	0 20	35	2 20	65	4 20	95	6 20	125	8 20	155	10 20
6	0 24	36	2 24	66	4 24	96	6 24	126	8 24	156	10 24
7	0 28	37	2 28	67	4 28	97	6 28	127	8 28	157	10 28
8	0 32	38	2 32	68	4 32	98	6 32	128	8 32	158	10 32
9	0 36	39	2 36	69	4 36	99	6 36	129	8 36	159	10 36
10	0 40	40	2 40	70	4 40	100	6 40	130	8 40	160	10 40
11	0 44	41	2 44	71	4 44	101	6 44	131	8 44	161	10 44
12	0 48	42	2 48	72	4 48	102	6 48	132	8 48	162	10 48
13	0 52	43	2 52	73	4 52	103	6 52	133	8 52	163	10 52
14	0 56	44	2 56	74	4 56	104	6 56	134	8 56	164	10 56
15	1 0	45	3 0	75	5 0	105	7 0	135	9 0	165	11 0
16	1 4	46	3 4	76	5 4	106	7 4	136	9 4	166	11 4
17	1 8	47	3 8	77	5 8	107	7 8	137	9 8	167	11 8
18	1 12	48	3 12	78	5 12	108	7 12	138	9 12	168	11 12
19	1 16	49	3 16	79	5 16	109	7 16	139	9 16	169	11 16
20	1 20	50	3 20	80	5 20	110	7 20	140	9 20	170	11 20
21	1 24	51	3 24	81	5 24	111	7 24	141	9 24	171	11 24
22	1 28	52	3 28	82	5 28	112	7 28	142	9 28	172	11 28
23	1 32	53	3 32	83	5 32	113	7 32	143	9 32	173	11 32
24	1 36	54	3 36	84	5 36	114	7 36	144	9 36	174	11 36
25	1 40	55	3 40	85	5 40	115	7 40	145	9 40	175	11 40
26	1 44	56	3 44	86	5 44	116	7 44	146	9 44	176	11 44
27	1 48	57	3 48	87	5 48	117	7 48	147	9 48	177	11 48
28	1 52	58	3 52	88	5 52	118	7 52	148	9 52	178	11 52
29	1 56	59	3 56	89	5 56	119	7 56	149	9 56	179	11 56
30	2 0	60	4 0	90	6 0	120	8 0	150	10 0	180	12 0

MERIDIONAL PARTS TO EVERY DEGREE OF THE QUADRANT.

D. M. P.	D. M. P.	D. M. P.	D. M. P.	D. M. P.	D. M. P.	D. M. P.	D. M. P.	D. M. P.	D. M. P.
0	0	10 603.1	20 1225.1	30 1888.4	40 2622.7	50 3474.5	60 4527.4	70 5965.9	80 8375.2
1	60.0	11 664.1	21 1289.2	31 1959.0	41 2701.6	51 3568.8	61 4649.2	71 6145.7	81 8739.1
2	120.0	12 725.3	22 1353.7	32 2029.4	42 2781.7	52 3665.2	62 4775.0	72 6334.8	82 9143.5
3	180.1	13 786.8	23 1418.6	33 2099.5	43 2863.1	53 3763.8	63 4904.0	73 6534.4	83 9605.8
4	240.2	14 848.5	24 1484.1	34 2171.5	44 2945.8	54 3864.6	64 5039.4	74 6745.7	84 10136.9
5	300.4	15 910.5	25 1550.0	35 2244.3	45 3029.9	55 3968.0	65 5178.8	75 6870.3	85 10764.6
6	360.7	16 972.7	26 1616.5	36 2318.0	46 3115.6	56 4073.9	66 5323.5	76 7210.1	86 11532.5
7	421.1	17 1035.3	27 1683.5	37 2382.6	47 3202.7	57 4182.6	67 5474.0	77 7467.2	87 12532.1
8	481.6	18 1090.2	28 1751.2	38 2468.3	48 3291.5	58 4294.3	68 5630.8	78 7744.6	88 13616.4
9	542.2	19 1161.5	29 1819.4	39 2544.9	49 3382.1	59 4409.1	69 5794.6	79 8045.7	89 16299.6

TABLE FOR REDUCING MEAN SOLAR TO SIDEREAL TIME. 65

Solar Days.	Add H.	Add M.	Add Sec.	Solar Hrs.	Add M.	Add Sec.	Solar Min.	Add Sec.	Solar Min.	Add Sec.	Solar Sec.	Add Sec.	Solar Sec.	Add Sec.
1	0	3	56.56	1	0	9.86	1	0.16	31	5.09	1	0.00	31	0.09
2	0	7	53.11	2	0	19.71	2	0.33	32	5.26	2	0.01	32	0.09
3	0	11	49.67	3	0	29.57	3	0.49	33	5.42	3	0.01	33	0.09
4	0	15	46.22	4	0	39.43	4	0.66	34	5.59	4	0.01	34	0.09
5	0	19	42.78	5	0	49.28	5	0.82	35	5.75	5	0.01	35	0.10
6	0	23	39.34	6	0	59.14	6	0.99	36	5.91	6	0.02	36	0.10
7	0	27	35.89	7	1	9.00	7	1.15	37	6.08	7	0.02	37	0.10
8	0	31	32.45	8	1	18.85	8	1.32	38	6.24	8	0.02	38	0.11
9	0	35	29.00	9	1	28.71	9	1.48	39	6.41	9	0.03	39	0.11
10	0	39	25.56	10	1	38.57	10	1.64	40	6.57	10	0.03	40	0.11
11	0	43	22.12	11	1	48.42	11	1.81	41	6.74	11	0.03	41	0.11
12	0	47	18.67	12	1	58.28	12	1.97	42	6.90	12	0.03	42	0.12
13	0	51	15.23	13	2	8.13	13	2.14	43	7.06	13	0.04	43	0.12
14	0	55	11.78	14	2	17.99	14	2.30	44	7.23	14	0.04	44	0.12
15	0	59	8.34	15	2	27.85	15	2.46	45	7.39	15	0.04	45	0.13
16	1	3	4.90	16	2	37.70	16	2.63	46	7.56	16	0.04	46	0.13
17	1	7	1.45	17	2	47.56	17	2.89	47	7.72	17	0.05	47	0.13
18	1	10	58.01	18	2	57.42	18	3.06	48	7.89	18	0.05	48	0.13
19	1	14	54.56	19	3	7.27	19	3.22	49	8.05	19	0.05	49	0.14
20	1	18	51.12	20	3	17.13	20	3.29	50	8.21	20	0.06	50	0.14
21	1	22	47.68	21	3	26.99	21	3.45	51	8.38	21	0.06	51	0.14
22	1	26	44.23	22	3	36.84	22	3.61	52	8.54	22	0.06	52	0.14
23	1	30	40.79	23	3	46.70	23	3.78	53	8.71	23	0.06	53	0.15
24	1	34	37.34	24	3	56.56	24	3.94	54	8.87	24	0.07	54	0.15
25	1	38	33.90				25	4.11	55	9.04	25	0.07	55	0.15
26	1	42	30.46				26	4.27	56	9.20	26	0.07	56	0.16
27	1	46	27.01				27	4.44	57	9.36	27	0.08	57	0.16
28	1	50	23.57				28	4.60	58	9.53	28	0.08	58	0.16
29	1	54	20.12				29	4.76	59	9.69	29	0.08	59	0.16
30	1	58	16.68				30	4.93	60	9.86	30	0.08	60	0.16

TABLE FOR REDUCING SIDEREAL TO MEAN SOLAR TIME.

Sid. Days.	Subtract H.	Subtract M.	Subtract Sec.	Sid. Hrs.	Subtract Min.	Subtract Sec.	Sid. Min.	Subtract Sec.	Sid. Sec.	Subtract Sec.	Sid. Sec.	Subtract Sec.
1	0	3	55.91	1	0	9.83	1	0.16	31	5.08	1	0.00
2	0	7	51.82	2	0	19.66	2	0.33	32	5.24	2	0.01
3	0	11	47.72	3	0	29.49	3	0.49	33	5.41	3	0.01
4	0	15	43.63	4	0	39.32	4	0.66	34	5.57	4	0.01
5	0	19	39.54	5	0	49.15	5	0.82	35	5.73	5	0.01
6	0	23	35.45	6	0	58.98	6	0.98	36	5.90	6	0.02
7	0	27	31.36	7	1	8.81	7	1.15	37	6.06	7	0.02
8	0	31	27.26	8	1	18.64	8	1.31	38	6.23	8	0.02
9	0	35	23.17	9	1	28.47	9	1.47	39	6.39	9	0.03
10	0	39	19.08	10	1	38.30	10	1.64	40	6.55	10	0.03
11	0	43	14.99	11	1	48.12	11	1.80	41	6.72	11	0.03
12	0	47	10.90	12	1	57.95	12	1.97	42	6.88	12	0.03
13	0	51	6.80	13	2	7.78	13	2.13	43	7.04	13	0.04
14	0	55	2.71	14	2	17.61	14	2.29	44	7.21	14	0.04
15	0	58	58.62	15	2	27.44	15	2.46	45	7.37	15	0.04
16	1	2	54.53	16	2	37.27	16	2.62	46	7.54	16	0.04
17	1	6	50.44	17	2	47.10	17	2.79	47	7.70	17	0.05
18	1	10	46.34	18	2	56.93	18	2.95	48	7.86	18	0.05
19	1	14	42.25	19	3	6.76	19	3.11	49	8.03	19	0.05
20	1	18	38.16	20	3	16.59	20	3.28	50	8.19	20	0.06
21	1	22	34.07	21	3	26.42	21	3.44	51	8.36	21	0.06
22	1	26	29.98	22	3	36.25	22	3.60	52	8.52	22	0.06
23	1	30	25.88	23	3	46.08	23	3.77	53	8.68	23	0.06
24	1	34	21.79	24	3	55.91	24	3.93	54	8.85	24	0.07
25	1	38	17.70				25	4.10	55	9.01	25	0.07
26	1	42	13.61				26	4.26	56	9.17	26	0.07
27	1	46	9.52				27	4.42	57	9.34	27	0.07
28	1	50	5.42				28	4.59	58	9.50	28	0.08
29	1	54	1.33				29	4.75	59	9.67	29	0.08
30	1	57	57.24				30	4.92	60	9.83	30	0.08

TABLE FOR FINDING THE EQUATION OF TIME, &c. FOR ANY GIVEN TIME
UNDER ANY GIVEN MERIDIAN.

TIME.		VARIATION.																	
For Eq.	For P. ^{rs}	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
Time H. Semi-	Moon's diam. or	m.	m.	m.	m.	m.	m.	m.	m.	m.	m.	m.	m.	m.	m.	m.	m.	m.	m.
Passage. Parallax		10	20	30	40	50	60	1	2	3	4	5	6	7	8	9			
h. m.	h. m.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
0 0	0 0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0 30	0 15	0.2	0.4	0.6	0.8	1.0	1.2	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
1 0	0 30	0.4	0.8	1.2	1.7	2.1	2.5	0.0	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.4
1 30	0 45	0.6	1.2	1.9	2.5	3.1	3.7	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.6	0.6	0.6
2 0	1 0	0.8	1.7	2.5	3.3	4.2	5.0	0.1	0.2	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.7	0.7	0.7
2 30	1 15	1.0	2.1	3.1	4.2	5.2	6.2	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	0.9	0.9	0.9
3 0	1 30	1.2	2.5	3.7	5.0	6.2	7.5	0.1	0.2	0.4	0.5	0.6	0.7	0.9	1.0	1.1	1.1	1.1	1.1
3 30	1 45	1.5	2.9	4.4	5.6	7.3	8.7	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.3	1.3	1.3	1.3
4 0	2 0	1.7	3.3	5.0	6.7	8.3	10.0	0.2	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.5	1.5	1.5	1.5
4 30	2 15	1.9	3.7	5.6	7.5	9.4	11.2	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.7	1.7	1.7
5 0	2 30	2.1	4.2	6.2	8.3	10.4	12.5	0.2	0.4	0.6	0.8	1.0	1.2	1.5	1.7	1.9	1.9	1.9	1.9
5 30	2 45	2.3	4.6	6.9	9.2	11.5	13.7	0.2	0.5	0.7	0.9	1.1	1.4	1.6	1.8	2.1	2.1	2.1	2.1
6 0	3 0	2.5	5.0	7.5	10.0	12.5	15.0	0.2	0.5	0.7	1.0	1.2	1.5	1.7	2.0	2.2	2.2	2.2	2.2
6 30	3 15	2.7	5.4	8.1	10.8	13.5	16.2	0.3	0.5	0.8	1.1	1.4	1.6	1.9	2.2	2.4	2.4	2.4	2.4
7 0	3 30	2.9	5.8	8.7	11.7	14.0	17.5	0.3	0.6	0.9	1.2	1.5	1.7	2.0	2.3	2.5	2.5	2.5	2.5
7 30	3 45	3.1	6.2	9.4	12.5	15.6	18.7	0.3	0.6	0.9	1.2	1.6	1.9	2.2	2.5	2.8	2.8	2.8	2.8
8 0	4 0	3.3	6.7	10.0	13.5	16.7	20.0	0.3	0.7	1.0	1.3	1.7	2.0	2.3	2.7	3.0	3.0	3.0	3.0
8 30	4 15	3.5	7.1	10.6	14.2	17.7	21.2	0.4	0.7	1.1	1.4	1.8	2.1	2.5	2.8	3.2	3.2	3.2	3.2
9 0	4 30	3.7	7.5	11.2	15.0	18.7	22.5	0.4	0.7	1.1	1.5	1.9	2.2	2.6	3.0	3.4	3.4	3.4	3.4
9 30	4 45	4.0	7.9	11.9	15.8	19.8	23.7	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	3.6	3.6	3.6
10 0	5 0	4.2	8.3	12.5	16.7	20.8	25.0	0.4	0.8	1.2	1.7	2.1	2.5	2.9	3.3	3.7	3.7	3.7	3.7
10 30	5 15	4.4	8.7	13.1	17.5	21.9	26.2	0.4	0.9	1.3	1.7	2.2	2.6	3.1	3.5	3.9	3.9	3.9	3.9
11 0	5 30	4.6	9.2	13.7	18.3	22.9	27.5	0.5	0.9	1.4	1.8	2.3	2.7	3.2	3.7	4.1	4.1	4.1	4.1
11 30	5 45	4.8	9.6	14.4	19.2	24.0	28.7	0.5	1.0	1.4	1.9	2.4	2.9	3.4	3.8	4.3	4.3	4.3	4.3
12 0	6 0	5.0	10.0	15.0	20.0	25.0	30.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	4.5	4.5	4.5
12 30	6 15	5.2	10.4	15.6	20.8	26.0	31.2	0.5	1.0	1.6	2.1	2.6	3.1	3.6	4.2	4.7	4.7	4.7	4.7
13 0	6 30	5.4	10.8	16.2	21.7	27.1	32.5	0.5	1.1	1.6	2.2	2.7	3.2	3.8	4.3	4.9	4.9	4.9	4.9
13 30	6 45	5.6	11.2	16.9	22.5	28.1	33.7	0.6	1.1	1.7	2.2	2.8	3.4	3.9	4.5	5.1	5.1	5.1	5.1
14 0	7 0	5.8	11.7	17.5	23.3	29.2	35.0	0.6	1.2	1.7	2.3	2.9	3.5	4.1	4.7	5.2	5.2	5.2	5.2
14 30	7 15	6.0	12.1	18.1	24.2	30.2	36.2	0.6	1.2	1.8	2.4	3.0	3.6	4.2	4.8	5.4	5.4	5.4	5.4
15 0	7 30	6.2	12.5	18.7	25.0	31.2	37.5	0.6	1.2	1.9	2.5	3.1	3.7	4.4	5.0	5.6	5.6	5.6	5.6
15 30	7 45	6.5	12.9	19.4	25.8	32.3	38.7	0.6	1.3	1.9	2.6	3.2	3.9	4.5	5.2	5.8	5.8	5.8	5.8
16 0	8 0	6.7	13.3	20.0	26.7	33.3	40.0	0.7	1.3	2.0	2.7	3.3	4.0	4.7	5.3	6.0	6.0	6.0	6.0
16 30	8 15	6.9	13.7	20.6	27.5	34.4	41.2	0.7	1.4	2.1	2.7	3.4	4.1	4.8	5.5	6.2	6.2	6.2	6.2
17 0	8 30	7.1	14.2	21.2	28.3	35.4	42.5	0.7	1.4	2.1	2.8	3.5	4.2	4.9	5.7	6.4	6.4	6.4	6.4
17 30	8 45	7.3	14.6	21.9	29.2	36.5	43.7	0.7	1.5	2.2	2.9	3.6	4.4	5.1	5.8	6.6	6.6	6.6	6.6
18 0	9 0	7.5	15.0	22.5	30.0	37.5	45.0	0.7	1.5	2.2	3.0	3.7	4.5	5.2	6.0	6.7	6.7	6.7	6.7
18 30	9 15	7.7	15.4	23.1	30.8	38.5	46.2	0.8	1.5	2.3	3.1	3.9	4.6	5.4	6.2	6.9	6.9	6.9	6.9
19 0	9 30	7.9	15.8	23.7	31.7	39.6	47.5	0.8	1.6	2.4	3.2	4.0	4.7	5.6	6.3	7.1	7.1	7.1	7.1
19 30	9 45	8.1	16.2	24.4	32.5	40.6	48.7	0.8	1.6	2.4	3.2	4.1	4.9	5.7	6.5	7.3	7.3	7.3	7.3
20 0	10 0	8.3	16.7	25.0	33.3	41.7	50.0	0.8	1.7	2.5	3.3	4.2	5.0	5.8	6.7	7.5	7.5	7.5	7.5
20 30	10 15	8.5	17.1	25.6	34.2	42.7	51.2	0.9	1.7	2.6	3.4	4.3	5.1	6.0	6.8	7.7	7.7	7.7	7.7
21 0	10 30	8.7	17.5	26.2	35.0	43.7	52.5	0.9	1.7	2.6	3.5	4.4	5.2	6.1	7.0	7.9	7.9	7.9	7.9
21 30	10 45	9.0	17.9	26.9	35.8	44.8	53.7	0.9	1.8	2.7	3.6	4.5	5.4	6.3	7.2	8.1	8.1	8.1	8.1
22 0	11 0	9.2	18.3	27.5	36.7	45.8	55.0	0.9	1.8	2.7	3.7	4.6	5.5	6.4	7.3	8.2	8.2	8.2	8.2
22 30	11 15	9.4	18.7	28.1	37.5	46.9	56.2	0.9	1.9	2.8	3.7	4.7	5.6	6.6	7.5	8.4	8.4	8.4	8.4
23 0	11 30	9.6	19.2	28.7	38.3	47.9	57.5	1.0	1.9	2.9	3.8	4.8	5.7	6.7	7.6	8.6	8.6	8.6	8.6
23 30	11 45	9.8	19.6	29.4	39.2	49.0	58.7	1.0	2.0	2.9	3.9	4.9	5.9	6.9	7.9	8.9	8.9	8.9	8.9
24 0	12 0	10.0	20.0	30.0	40.0	50.0	60.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	9.0	9.0	9.0

DIP OF THE HORIZON.

Height of the Eye in Feet.	Dip of the Horizon.	Height of the Eye in Feet.	Dip of the Horizon.
1	0' 59"	19	4' 17"
2	1 24	20	4 24
3	1 42	21	4 31
4	1 58	22	4 37
5	2 12	23	4 43
6	2 25	24	4 49
7	2 36	26	5 1
8	2 47	28	5 13
9	2 57	30	5 23
10	3 7	35	5 49
11	3 16	40	6 14
12	3 25	45	6 36
13	3 33	50	6 58
14	3 41	60	7 37
15	3 49	70	8 14
16	3 56	80	8 48
17	4 3	90	9 20
18	4 11	100	9 51

DIP AT DIFFERENT DISTANCES FROM THE OBSERVER.

Distance in Miles.	Height of the Eye in Feet.							
	5	10	15	20	25	30	35	40
1	11'	23'	34'	45'	57'	68'	79'	91'
2	6	12	17	23	28	34	40	45
3	4	8	12	15	19	23	27	30
4	3	6	9	12	15	17	20	23
5	3	5	7	10	12	14	16	19
6	3	4	6	8	10	12	14	16
7	2	4	5	7	8	9	11	12
8	2	3	4	6	7	8	9	10
9	2	3	4	5	6	7	8	9
10	2	3	4	5	6	6	7	8
11	2	3	4	5	5	6	7	7
12	2	3	4	4	5	6	6	7
13	2	3	4	4	5	5	6	6
14	2	3	4	4	5	5	6	6
15	2	3	4	4	5	5	6	6
16	2	3	4	4	5	5	6	6
17	2	3	4	4	5	5	6	6
18	2	3	4	4	5	5	6	6

TABLE FOR FINDING THE DISTANCE OF TERRESTRIAL OBJECTS AT SEA.

Height in Feet.	Dist. in Miles.	Height in Feet.	Dist. in Miles.	Height in Feet.	Dist. in Miles.	Height in Feet.	Dist. in Miles.	Height in Feet.	Dist. in Miles.	Height in Feet.	Dist. in Miles.	Height in Feet.	Dist. in Miles.
1	1-15	25	5-74	49	8-0	180	15-4	420	23-5	820	32-9	2500	57-4
2	1-62	26	5-86	50	8-1	190	15-8	430	23-8	840	33-3	2600	58-6
3	1-99	27	5-97	55	8-5	200	16-2	440	24-1	860	33-7	2700	59-7
4	2-30	28	6-08	60	8-9	210	16-6	450	24-4	880	34-1	2800	60-8
5	2-57	29	6-18	65	9-3	220	17-0	460	24-6	900	34-5	2900	61-8
6	2-81	30	6-30	70	9-6	230	17-4	470	24-9	920	34-8	3000	63-0
7	3-04	31	6-40	75	9-9	240	17-8	480	25-2	940	35-2	3100	64-0
8	3-25	32	6-50	80	10-3	250	18-2	490	25-4	960	35-6	3200	65-0
9	3-45	33	6-60	85	10-6	260	18-5	500	25-7	980	36-0	3300	66-0
10	3-63	34	6-70	90	10-9	270	18-9	520	26-2	1000	36-3	3400	67-0
11	3-81	35	6-80	95	11-2	280	19-2	540	26-7	1100	38-1	3500	68-0
12	3-93	36	6-90	100	11-5	290	19-6	560	27-2	1200	39-8	3600	69-0
13	4-14	37	6-99	105	11-8	300	19-9	580	27-7	1300	41-4	3700	69-9
14	4-30	38	7-09	110	12-1	310	20-2	600	28-1	1400	43-0	3800	70-9
15	4-45	39	7-17	115	12-3	320	20-6	620	28-6	1500	44-5	3900	71-7
16	4-60	40	7-27	120	12-6	330	20-9	640	29-1	1600	46-0	4000	72-7
17	4-73	41	7-36	125	12-8	340	21-2	660	29-5	1700	47-3	4100	73-6
18	4-87	42	7-44	130	13-1	350	21-5	680	30-0	1800	48-7	4200	74-4
19	5-01	43	7-54	135	13-3	360	21-8	700	30-4	1900	50-1	4300	75-4
20	5-14	44	7-62	140	13-6	370	22-1	720	30-8	2000	51-4	4400	76-2
21	5-26	45	7-70	145	13-8	380	22-4	740	31-2	2100	52-6	4500	77-0
22	5-39	46	7-79	150	14-1	390	22-7	760	31-7	2200	53-9	4700	78-8
23	5-51	47	7-88	160	14-5	400	23-0	780	32-1	2300	55-1	5000	81-2
24	5-62	48	7-96	170	15-0	410	23-3	800	32-5	2400	56-2	1 mile	83-5

TABLE I.

Barom.	Feet.	Diff.	Barom.	Feet.	Diff.	Barom.	Feet.	Diff.
14.600	1431	90	17.400	6017	75	20.200	9916	65
.650	1521		.450	6092		.250	9981	
.700	1610	89	.500	6167		.300	10045	64
.750	1699		.550	6241	74	.350	10109	
.800	1787	88	.600	6315		.400	10173	
.850	1875		.650	6389		.450	10237	
.900	1963		.700	6463		.500	10301	
.950	2050	87	.750	6537		.550	10365	
15.000	2137		.800	6610	73	.600	10428	63
.050	2224		.850	6682		.650	10491	
.100	2311		.900	6756		.700	10554	
.150	2397	86	.950	6829		.750	10617	
.200	2483		18.000	6902		.800	10680	
.250	2569		.050	6975		.850	10743	
.300	2655		.100	7047	72	.900	10805	62
.350	2740	85	.150	7119		.950	10867	
.400	2825		.200	7191		21.000	10929	
.450	2910		.250	7263		.050	10991	
.500	2995		.300	7335		.100	11053	
.550	3079	84	.350	7406	71	.150	11115	
.600	3163		.400	7477		.200	11177	
.650	3247		.450	7548		.250	11239	
.700	3331		.500	7619		.300	11300	61
.750	3414	83	.550	7689	70	.350	11361	
.800	3497		.600	7759		.400	11422	
.850	3580		.650	7829		.450	11483	
.900	3662	82	.700	7899		.500	11544	
.950	3744		.750	7969		.550	11605	
16.000	3826		.800	8038	69	.600	11666	
.050	3907	81	.850	8107		.650	11726	60
.100	3988		.900	8176		.700	11786	
.150	4069		.950	8245		.750	11846	
.200	4150		19.000	8314		.800	11906	
.250	4230	80	.050	8383		.850	11966	
.300	4310		.100	8451	68	.900	12026	
.350	4390		.150	8519		.950	12086	
.400	4470		.200	8587		22.000	12145	59
.450	4549	79	.250	8655		.050	12204	
.500	4628		.300	8723		.100	12263	
.550	4707		.350	8791		.150	12322	
.600	4786		.400	8859		.200	12381	
.650	4865		.450	8926	67	.250	12440	
.700	4943	78	.500	8993		.300	12499	
.750	5021		.550	9060		.350	12557	58
.800	5099		.600	9127		.400	12615	
.850	5177		.650	9194		.450	12673	
.900	5255		.700	9261		.500	12731	
.950	5322	77	.750	9327	66	.550	12789	
17.000	5409		.800	9393		.600	12847	
.050	5486		.850	9459		.650	12905	
.100	5563		.900	9525		.700	12963	
.150	5639	76	.950	9591		.750	13020	57
.200	5715		20.000	9656	65	.800	13077	
.250	5791		.050	9721		.850	13134	
.300	5867		.100	9786		.900	13191	
.350	5942	75	.150	9851		.950	13248	

TABLE I.—Continued.

Barom.	Feet.	Diff.	Barom.	Feet.	Diff.	Barom.	Feet.	Diff.
23·000	13305	57	25·750	16257	51	28·500	18908	46
·050	13362		·800	16308		·550	18954	
·100	13419		·850	16359		·600	19000	
·150	13476		·900	16410		·650	19046	
·200	13532	56	·950	16460	50	·700	19092	
·250	13588		26·000	16510		·750	19137	45
·300	13644		·050	16560		·800	19182	
·350	13700		·100	16610		·850	19227	
·400	13756		·150	16660		·900	19272	
·450	13812		·200	16710		·950	19317	
·500	13868		·250	16760		29·000	19362	
·550	13924		·300	16810		·050	19407	
·600	13979	55	·350	16860		·100	19452	
·650	14034		·400	16910		·150	19497	
·700	14089		·450	16959	49	·200	19542	
·750	14144		·500	17008		·250	19587	
·800	14199		·550	17057		·300	19632	
·850	14254		·600	17106		·350	19676	44
·900	14309		·650	17155		·400	19720	
·950	14364		·700	17204		·450	19764	
24·000	14417		·750	17253		·500	19808	
·050	14471	54	·800	17302		·550	19852	
·100	14525		·850	17351		·600	19896	
·150	14579		·900	17400		·650	19940	
·200	14633		·950	17448	48	·700	19984	
·250	14687		27·000	17496		·750	20028	
·300	14741		·050	17544		·800	20072	
·350	14795		·100	17592		·850	20116	
·400	14849		·150	17640		·900	20160	
·450	14903		·200	17688		·950	20204	
·500	14956	53	·250	17736		30·000	20248	
·550	15009		·300	17784		·050	20293	43
·600	15062		·350	17832		·100	20336	
·650	15115		·400	17880		·150	20379	
·700	15168		·450	17928		·200	20422	
·750	15231		·500	17976		·250	20465	
·800	15274		·550	18023	47	·300	20508	
·850	15327		·600	18070		·350	20551	
·900	15380		·650	18117		·400	20594	
·950	15432	52	·700	18164		·450	20637	
25·000	15484		·750	18211		·500	20680	
·050	15536		·800	18258		·550	20723	
·100	15588		·850	18305		·600	20766	
·150	15640		·900	18352		·650	20809	
·200	15692		·950	18399		·700	20852	
·250	15744		28·000	18446		·750	20894	42
·300	15796		·050	18493		·800	20936	
·350	15848		·100	18540		·850	20978	
·400	15900		·150	18586	46	·900	21020	
·450	15951	51	·200	18632		·950	21062	
·500	16002		·250	18678		31·000	21104	
·550	16053		·300	18724		·050	21146	
·600	16104		·350	18770		·100	21188	
·650	16155		·400	18816				
·700	16205		·450	18862				

TABLE II.

Diff.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	20.	30.	40.
90	1.8	3.6	5.4	7.2	9.0	10.8	12.6	14.4	16.2	18.0	36.0	54.0	72.0
89	1.8	3.5	5.3	7.1	8.9	10.6	12.4	14.2	16.0	17.8	35.6	53.4	71.2
88	1.7	3.5	5.3	7.0	8.8	10.5	12.3	14.0	15.8	17.6	35.2	52.8	70.4
87	1.7	3.5	5.2	6.9	8.7	10.4	12.2	13.9	15.4	17.4	34.8	52.2	69.6
86	1.7	3.4	5.2	6.9	8.6	10.3	12.0	13.7	15.5	17.2	34.4	51.6	68.8
85	1.7	3.4	5.1	6.8	8.5	10.2	11.9	13.6	15.3	17.0	34.0	51.0	68.0
84	1.7	3.4	5.0	6.7	8.4	10.0	11.7	13.4	15.1	16.8	33.6	50.4	67.2
83	1.7	3.3	5.0	6.6	8.3	9.9	11.6	13.3	14.9	16.6	33.2	49.8	66.4
82	1.6	3.3	4.9	6.6	8.2	9.8	11.5	13.1	14.7	16.4	32.8	49.2	65.6
81	1.6	3.2	4.9	6.5	8.1	9.7	11.3	12.9	14.5	16.2	32.4	48.6	64.8
80	1.6	3.2	4.8	6.4	8.0	9.6	11.2	12.8	14.4	16.0	32.0	48.0	64.0
79	1.6	3.2	4.7	6.3	7.9	9.5	11.0	12.6	14.2	15.8	31.6	47.4	63.2
78	1.6	3.1	4.7	6.2	7.8	9.3	10.9	12.5	14.0	15.6	31.2	46.8	62.4
77	1.5	3.1	4.6	6.2	7.7	9.2	10.7	12.3	13.8	15.4	30.8	46.2	61.6
76	1.5	3.0	4.6	6.1	7.6	9.1	10.6	12.1	13.7	15.2	30.4	45.6	60.8
75	1.5	3.0	4.5	6.0	7.5	9.0	10.5	12.0	13.5	15.0	30.0	45.0	60.0
74	1.5	3.0	4.4	5.9	7.4	8.8	10.3	11.8	13.3	14.8	29.6	44.4	59.2
73	1.5	2.9	4.4	5.8	7.3	8.7	10.2	11.7	13.1	14.6	29.2	43.8	58.4
72	1.4	2.9	4.3	5.8	7.2	8.6	10.1	11.5	12.9	14.4	28.8	43.2	57.6
71	1.4	2.8	4.3	5.7	7.1	8.5	9.9	11.3	12.7	14.2	28.4	42.6	56.8
70	1.4	2.8	4.2	5.6	7.0	8.4	9.8	11.2	12.6	14.0	28.0	42.0	56.0
69	1.4	2.8	4.1	5.5	6.9	8.3	9.6	11.0	12.4	13.8	27.6	41.4	55.2
68	1.4	2.7	4.1	5.4	6.8	8.1	9.5	10.9	12.2	13.7	27.2	40.8	54.4
67	1.3	2.7	4.0	5.4	6.7	8.0	9.4	10.7	12.0	13.4	26.8	40.2	53.6
66	1.3	2.6	4.0	5.3	6.6	7.9	9.2	10.5	11.8	13.2	26.4	39.6	52.8
65	1.3	2.6	3.9	5.2	6.5	7.8	9.1	10.4	11.7	13.0	26.0	39.0	52.0
64	1.3	2.6	3.8	5.1	6.4	7.7	8.9	10.2	11.5	12.8	25.6	38.4	51.2
63	1.3	2.5	3.8	5.0	6.3	7.5	8.8	10.1	11.3	12.6	25.2	37.8	50.4
62	1.2	2.5	3.7	5.0	6.2	7.4	8.7	9.9	11.1	12.4	24.8	37.2	49.6
61	1.2	2.4	3.7	4.9	6.1	7.3	8.5	9.7	11.0	12.2	24.4	36.6	48.8
60	1.2	2.4	3.6	4.8	6.0	7.2	8.4	9.6	10.8	12.0	24.0	36.0	48.0
59	1.2	2.4	3.5	4.7	5.9	7.1	8.2	9.4	10.6	11.8	23.6	35.4	47.2
58	1.2	2.3	3.5	4.6	5.8	6.9	8.1	9.2	10.4	11.6	23.2	34.8	46.4
57	1.1	2.3	3.4	4.6	5.7	6.8	7.9	9.1	10.2	11.4	22.8	34.2	45.6
56	1.1	2.2	3.4	4.5	5.6	6.7	7.8	8.9	10.1	11.2	22.4	33.6	44.8
55	1.1	2.2	3.3	4.4	5.5	6.6	7.7	8.8	9.9	11.0	22.0	33.0	44.0
54	1.1	2.2	3.2	4.3	5.4	6.5	7.5	8.6	9.7	10.8	21.6	32.4	43.2
53	1.1	2.1	3.2	4.2	5.3	6.3	7.4	8.5	9.5	10.6	21.2	31.8	42.4
52	1.0	2.1	3.1	4.2	5.2	6.2	7.2	8.3	9.3	10.4	20.8	31.2	41.6
51	1.0	2.0	3.1	4.1	5.1	6.1	7.1	8.1	9.2	10.2	20.4	30.6	40.8
50	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	20.0	30.0	40.0
49	1.0	2.0	2.9	3.9	4.9	5.9	6.8	7.8	8.8	9.8	19.6	29.4	39.2
48	1.0	1.9	2.9	3.8	4.8	5.7	6.7	7.7	8.6	9.6	19.2	28.8	38.4
47	0.9	1.9	2.8	3.8	4.7	5.6	6.6	7.5	8.4	9.4	18.8	28.2	37.6
46	0.9	1.8	2.8	3.7	4.6	5.5	6.4	7.3	8.3	9.2	18.4	27.6	36.8
45	0.9	1.8	2.7	3.6	4.5	5.4	6.3	7.2	8.1	9.0	18.0	27.0	36.0
44	0.9	1.8	2.6	3.5	4.4	5.3	6.1	7.0	7.9	8.8	17.6	26.4	35.2
43	0.9	1.7	2.6	3.4	4.3	5.1	6.0	6.9	7.7	8.6	17.2	25.8	34.4
42	0.8	1.7	2.5	3.4	4.2	5.0	5.9	6.7	7.5	8.4	16.8	25.2	33.6

TABLE III.

Thr.	Feet.	Thr.	Feet.	Thr.	Feet.	Thr.	Feet.	Thr.	Feet.	Thr.	Feet.	Thr.	Feet.	Thr.	Feet.
0.5	1.3	5.0	13.4	9.5	25.2	14.0	37.7	18.5	49.5	23.0	61.7	27.5	73.8	32.0	86.0
1.0	2.7	5.5	14.9	10.0	26.7	14.5	38.9	19.0	51.0	23.5	63.0	28.0	74.9	32.5	87.1
1.5	4.1	6.0	16.1	10.5	28.1	15.0	40.4	19.5	52.4	24.0	64.4	28.5	76.3	33.0	88.6
2.0	5.4	6.5	17.4	11.0	29.3	15.5	41.3	20.0	53.7	24.5	65.6	29.0	77.6	33.5	89.9
2.5	6.9	7.0	18.8	11.5	30.8	16.0	42.8	20.5	55.1	25.0	67.1	29.5	79.1	34.0	91.3
3.0	7.8	7.5	20.0	12.0	32.1	16.5	44.0	21.0	56.4	25.5	68.4	30.0	80.4	34.5	92.3
3.5	9.3	8.0	21.6	12.5	33.5	17.0	45.5	21.5	57.5	26.0	69.8	30.5	81.8	35.0	93.7
4.0	10.5	8.5	23.0	13.0	34.7	17.5	46.9	22.0	58.9	26.5	71.2	31.0	83.0	35.5	95.2
4.5	12.0	9.0	24.2	13.5	36.2	18.0	48.0	22.5	60.2	27.0	72.5	31.5	84.7	36.0	96.4

TABLE IV.

Feet.	0.	5°.	10°.	15°.	20°.	25°.	30°.	35°.	40°.	45°.	50°.	55°.	60°.
500	3.0	3.0	3.0	2.4	2.5	2.5	1.8	1.9	1.4	1.5	1.7	1.0	0.8
1000	5.9	5.9	5.9	5.3	5.0	5.0	4.3	4.2	3.4	3.0	2.7	2.0	1.4
1500	8.8	8.8	8.8	8.2	7.6	7.4	6.7	6.2	5.2	4.5	3.8	3.0	2.2
2000	11.3	11.3	11.3	10.7	10.0	9.4	8.6	7.9	6.7	6.0	5.2	3.9	2.8
2500	14.0	14.0	14.0	13.4	12.7	11.9	10.9	9.7	8.7	7.4	6.3	5.3	4.2
3000	16.9	16.9	16.9	16.0	15.3	14.3	13.0	11.5	10.3	9.2	7.7	6.5	5.2
3500	20.1	20.1	19.9	18.6	17.7	16.8	15.0	13.4	12.0	10.8	9.1	7.6	6.3
4000	23.4	23.4	22.7	21.4	20.0	19.3	17.0	15.3	13.9	12.2	10.4	8.6	7.0
4500	26.4	26.4	25.7	24.4	22.8	21.6	19.5	17.3	15.4	13.5	11.6	9.6	7.8
5000	28.9	28.9	28.2	27.2	25.5	23.8	21.8	19.3	17.4	14.9	12.8	10.6	8.6
5500	31.8	31.8	31.1	30.2	28.5	26.3	24.3	21.3	19.3	16.5	14.1	11.7	9.5
6000	34.7	34.6	33.9	32.7	31.3	28.7	26.6	23.4	21.0	18.0	15.3	12.7	10.3
6500	37.7	37.4	36.8	35.7	33.8	31.2	28.5	25.3	22.8	19.5	16.5	13.6	11.1
7000	40.7	40.1	39.9	38.5	36.4	33.6	30.8	27.3	24.3	21.0	17.8	14.6	11.9
7500	43.7	43.3	43.0	41.4	39.0	36.1	33.1	29.3	26.1	22.5	19.0	15.8	12.7
8000	46.6	46.6	46.0	44.4	41.7	38.6	35.3	31.5	28.1	24.1	20.5	17.0	13.7
8500	49.6	49.6	49.0	47.0	44.4	41.1	37.8	34.2	30.1	26.1	22.2	18.2	14.7
9000	53.1	52.9	52.5	50.0	47.4	43.6	40.3	36.5	32.1	28.1	23.7	19.7	15.9
9500	56.4	56.2	55.8	53.1	50.2	46.2	42.9	38.6	33.8	29.8	25.2	21.0	17.1
10000	59.7	59.1	58.7	56.1	52.8	48.8	45.4	40.7	36.0	31.4	26.7	22.0	17.9
10500	62.7	62.0	61.3	59.0	55.7	51.5	47.9	43.0	37.7	33.1	28.2	23.0	18.7
11000	66.1	65.5	64.9	62.3	59.2	54.4	50.6	45.5	40.0	35.1	29.7	24.7	19.9
11500	69.4	68.9	68.1	65.3	62.3	57.4	53.2	47.8	42.4	36.8	31.2	26.2	21.1
12000	72.7	72.3	71.3	68.0	65.3	60.1	55.7	50.1	44.8	38.8	32.8	27.4	22.1
12500	75.9	75.3	74.3	71.0	67.8	62.9	58.2	52.4	47.0	40.6	34.3	28.4	23.1
13000	79.8	79.2	77.6	74.3	71.0	65.9	60.7	55.0	49.0	42.5	36.2	30.3	24.5
13500	83.1	82.5	81.2	77.7	73.6	69.0	63.6	57.6	51.0	44.6	38.2	32.2	26.1
14000	86.7	86.0	84.6	81.4	76.9	72.3	66.6	60.2	53.3	47.0	40.3	33.9	27.0
14500	90.6	90.0	88.3	85.1	80.1	75.8	69.6	63.1	55.8	49.5	42.6	35.6	29.0
15000	94.1	93.5	91.8	88.3	83.4	79.1	72.6	66.0	58.5	51.8	44.3	37.4	30.6
15500	97.8	97.2	95.3	91.6	86.8	81.9	75.4	68.6	61.0	53.7	46.0	38.9	32.0
16000	101.5	100.9	98.7	95.0	90.5	85.3	78.2	71.2	63.5	55.7	47.8	40.5	33.4
16500	104.9	104.3	101.9	98.3	93.8	88.2	81.2	73.7	65.7	57.5	49.5	42.0	34.7
17000	107.8	107.2	104.9	101.3	97.0	91.4	84.0	76.1	67.9	59.4	51.3	43.5	36.0
17500	111.1	110.4	108.5	104.8	99.8	94.5	86.5	78.6	70.2	61.7	53.0	45.0	37.3
18000	114.5	113.8	111.9	108.2	102.8	97.2	89.1	81.1	72.5	64.0	54.9	46.4	38.4
18500	118.0	117.3	115.0	111.4	106.0	99.8	91.9	83.6	74.8	65.8	56.8	48.0	39.5
19000	121.5	120.9	118.2	114.6	108.7	102.5	94.6	86.2	77.3	67.8	58.3	49.4	40.6
19500	125.0	124.4	121.7	117.9	111.5	105.1	97.4	88.7	79.8	69.8	60.1	51.0	42.1

Fah.	Reau.	Centl.	Fah.	Reau.	Centl.	Fah.	Reau.	Centl.	Fah.	Reau.	Centl.
212	80.0	100.0	148	51.5	64.4	84	23.1	28.8	20	-5.3	-6.6
211	79.5	99.4	147	51.1	63.8	83	22.6	28.3	19	-5.7	-7.2
210	79.1	98.8	146	50.6	63.3	82	22.2	27.7	18	-6.2	-7.7
209	78.6	98.3	145	50.2	62.7	81	21.7	27.2	17	-6.6	-8.3
208	78.2	97.7	144	49.7	62.2	80	21.3	26.6	16	-7.1	-8.8
207	77.7	97.2	143	49.3	61.6	79	20.8	26.1	15	-7.5	-9.5
206	77.3	96.6	142	48.8	61.1	78	20.4	25.5	14	-8.0	-10.0
205	76.8	96.1	141	48.4	60.5	77	20.0	25.0	13	-8.4	-10.5
204	76.4	95.5	140	48.0	60.0	76	19.5	24.4	12	-8.8	-11.1
203	76.0	95.0	139	47.5	59.4	75	19.1	23.8	11	-9.3	-11.6
202	75.5	94.4	138	47.1	58.8	74	18.6	23.3	10	-9.7	-12.2
201	75.1	93.8	137	46.6	58.3	73	18.2	22.7	9	-10.2	-12.7
200	74.6	93.3	136	46.2	57.7	72	17.7	22.2	8	-10.6	-13.3
199	74.2	92.7	135	45.7	57.2	71	17.3	21.6	7	-11.1	-13.8
198	73.7	92.2	134	45.3	56.6	70	16.8	21.1	6	-11.5	-14.4
197	73.3	91.6	133	44.8	56.1	69	16.4	20.5	5	-12.0	-15.0
196	72.8	91.1	132	44.4	55.5	68	16.0	20.0	4	-12.4	-15.5
195	72.4	90.5	131	44.0	55.0	67	15.5	19.4	3	-12.8	-16.1
194	72.0	90.0	130	43.5	54.4	66	15.1	18.8	2	-13.3	-16.6
193	71.5	89.4	129	43.1	53.8	65	14.6	18.3	1	-13.7	-17.2
192	71.1	88.8	128	42.6	53.3	64	14.2	17.7	0	-14.2	-17.7
191	70.6	88.3	127	42.2	52.7	63	13.7	17.2	-1	-14.6	-18.3
190	70.2	87.7	126	41.7	52.2	62	13.3	16.6	-2	-15.1	-18.8
189	69.7	87.2	125	41.3	51.6	61	12.8	16.1	-3	-15.5	-19.4
188	69.3	86.6	124	40.8	51.1	60	12.4	15.5	-4	-16.0	-20.0
187	68.8	86.1	123	40.4	50.5	59	12.0	15.0	-5	-16.4	-20.5
186	68.4	85.5	122	40.0	50.0	58	11.5	14.4	-6	-16.8	-21.1
185	68.0	85.0	121	39.5	49.4	57	11.1	13.8	-7	-17.3	-21.6
184	67.5	84.4	120	39.1	48.8	56	10.6	13.3	-8	-17.7	-22.2
183	67.1	83.8	119	38.6	48.3	55	10.2	12.7	-9	-18.2	-22.7
182	66.6	83.3	118	38.2	47.7	54	9.7	12.2	-10	-18.6	-23.3
181	66.2	82.7	117	37.7	47.2	53	9.3	11.6	-11	-19.1	-23.8
180	65.7	82.2	116	37.3	46.6	52	8.8	11.1	-12	-19.5	-24.4
179	65.3	81.6	115	36.8	46.1	51	8.4	10.5	-13	-20.0	-25.0
178	64.8	81.1	114	36.4	45.5	50	8.0	10.0	-14	-20.4	-25.5
177	64.4	80.5	113	36.0	45.0	49	7.5	9.4	-15	-20.8	-26.1
176	64.0	80.0	112	35.5	44.4	48	7.1	8.8	-16	-21.3	-26.6
175	63.5	79.4	111	35.1	43.8	47	6.6	8.3	-17	-21.7	-27.2
174	63.1	78.8	110	34.6	43.3	46	6.2	7.7	-18	-22.2	-27.7
173	62.6	78.3	109	34.2	42.7	45	5.7	7.2	-19	-22.6	-28.3
172	62.2	77.7	108	33.7	42.2	44	5.3	6.6	-20	-23.1	-28.8
171	61.7	77.2	107	33.3	41.6	43	4.8	6.1	-21	-23.5	-29.4
170	61.3	76.6	106	32.8	41.1	42	4.4	5.5	-22	-24.0	-30.0
169	60.8	76.1	105	32.4	40.5	41	4.0	5.0	-23	-24.4	-30.5
168	60.4	75.5	104	32.0	40.0	40	3.5	4.4	-24	-24.8	-31.1
167	60.0	75.0	103	31.5	39.4	39	3.1	3.8	-25	-25.3	-31.6
166	59.5	74.4	102	31.1	38.8	38	2.6	3.3	-26	-25.7	-32.2
165	59.1	73.8	101	30.6	38.3	37	2.2	2.7	-27	-26.2	-32.7
164	58.6	73.3	100	30.2	37.7	36	1.7	2.2	-28	-26.6	-33.3
163	58.2	72.7	99	29.7	37.2	35	1.3	1.6	-29	-27.1	-33.8
162	57.7	72.2	98	29.3	36.6	34	0.8	1.1	-30	-27.5	-34.4
161	57.3	71.6	97	28.8	36.1	33	0.4	0.5	-31	-28.0	-35.0
160	56.8	71.1	96	28.4	35.5	32	0.0	0.0	-32	-28.4	-35.5
159	56.4	70.5	95	28.0	35.0	31	-0.4	-0.5	-33	-28.8	-36.1
158	56.0	70.0	94	27.5	34.4	30	-0.8	-1.1	-34	-29.3	-36.6
157	55.5	69.4	93	27.1	33.8	29	-1.3	-1.6	-35	-29.7	-37.2
156	55.1	68.8	92	26.6	33.3	28	-1.7	-2.2	-36	-30.2	-37.7
155	54.6	68.3	91	26.2	32.7	27	-2.2	-2.7	-37	-30.6	-38.3
154	54.2	67.7	90	25.7	32.2	26	-2.6	-3.3	-38	-31.1	-38.8
153	53.7	67.2	89	25.3	31.6	25	-3.1	-3.6	-39	-31.5	-39.4
152	53.3	66.6	88	24.8	31.1	24	-3.5	-4.4	-40	-32.0	-40.0
151	52.8	66.1	87	24.4	30.5	23	-4.0	-5.0			
150	52.4	65.5	86	24.0	30.0	22	-4.4	-5.5			
149	52.0	65.0	85	23.5	29.4	21	-4.8	-6.1			

TABLE OF THE HEIGHT OF THE APPARENT LEVEL ABOVE THE TRUE.

Dist. Chains.	Subtr. Inches.	Dist. Ch.	Subtr. Inches.	Dist. Ch.	Subtr. Inches.	Dist. Ch.	Subtr. Inches.	Dist. Miles.	Subtract Ft. In.
1	0.000	14	0.24	27	0.91	40	2.00	1	0 8
2	0.005	15	0.28	28	0.98	45	2.28	2	2 8
3	0.012	16	0.32	29	0.05	50	3.12	3	6 0
4	0.02	17	0.36	30	0.12	55	3.76	4	10 7
5	0.03	18	0.40	31	0.19	60	4.50	5	16 7
6	0.04	19	0.45	32	0.27	65	5.31	6	23 11
7	0.06	20	0.50	33	1.35	70	6.12	7	32 6
8	0.08	21	0.55	34	1.44	75	7.03	8	42 6
9	0.10	22	0.60	35	1.53	80	8.00	9	53 9
10	0.12	23	0.66	36	1.62	85	9.03	10	66 4
11	0.15	24	0.72	37	1.71	90	10.12	11	80 3
12	0.18	25	0.78	38	1.80	95	11.28	12	95 7
13	0.21	26	0.84	39	1.90	100	11.50	13	112 2

TABLE OF LINKS TO BE SUBTRACTED FROM EACH CHAIN, IN AN ASCENDING OR DESCENDING LINE, IN ORDER TO REDUCE IT TO THE HORIZONTAL MEASURE.

PART I.				PART II.					
Deg.	Links.	Deg.	Links.	D.	M.	Links.	D.	M.	Links.
1	0.02	11	1.34	4	3	$\frac{1}{2}$	13	23	24
2	0.06	12	2.19	5	44	$\frac{1}{2}$	14	4	3
3	0.14	13	2.57	7	1	$\frac{1}{2}$	14	39	34
4	0.25	14	2.97	8	7	1	15	12	34
5	0.33	15	3.41	9	4	14	15	44	34
6	0.55	16	3.88	9	56	14	16	16	4
7	0.75	17	4.37	10	44	14	16	46	44
8	0.98	18	4.90	11	29	2	17	15	44
9	1.24	19	5.45	12	11	24	17	44	44
10	1.52	20	6.03	12	50	24	18	12	5

TABLE OF ANGLES CORRESPONDING TO SUBTENSES MEASURED IN LINKS, THE RADIUS BEING HALF A CHAIN.

L.	D.	M.	L.	D.	M.	L.	D.	M.	L.	D.	M.	L.	D.	M.	L.	D.	M.
6	6	53	21	24	14	36	42	12	51	61	20	66	82	36	81	108	12
7	3	2	22	25	25	37	43	26	52	62	40	67	84	8	82	110	10
8	9	11	23	26	36	38	44	40	53	64	0	68	85	42	83	112	12
9	10	20	24	27	46	39	45	54	54	65	22	69	87	16	84	114	17
10	11	29	25	28	58	40	47	10	55	66	44	70	88	52	85	116	26
11	12	38	26	30	8	41	48	24	56	68	6	71	90	28	86	118	36
12	13	47	27	31	20	42	49	40	57	69	30	72	92	6	87	120	55
13	14	56	28	32	31	43	50	56	58	70	54	73	93	46	88	123	17
14	16	6	29	33	43	44	52	12	59	72	18	74	95	28	89	125	45
15	17	15	30	34	55	45	53	30	60	73	44	75	97	11	90	128	19
16	18	25	31	36	7	46	54	46	61	75	10	76	98	56	91	131	0
17	19	34	32	37	20	47	56	4	62	76	38	77	100	42	92	133	52
18	20	44	33	38	32	48	57	22	63	78	6	78	102	32	93	136	52
19	21	54	34	39	45	49	58	41	64	79	35	79	104	22	94	140	8
20	23	4	35	40	58	50	60	0	65	81	7	80	106	16	95	143	38

A TABLE

SHOWING THE LENGTHS OF THE SIDES OF INSCRIBED AND CIRCUMSCRIBED POLYGONS, THE DIAMETER OF THE CIRCLE BEING UNITY.

No. of Sides.	Side of Inscribed Polygon.	Side of Circum-scribed Polygon.	No. of Sides.	Side of Inscribed Polygon.	Side of Circum-scribed Polygon.
3	•0660254	1•7320508	21	•1490422	•1507257
4	•7071068	1•0000000	22	•1423148	•1437783
5	•5877853	•7265425	23	•1361666	•1374468
6	•5000000	•5773503	24	•1305262	•1316525
7	•4338837	•4815745	25	•1253332	•1263294
8	•3826834	•4142136	26	•1205366	•1214219
9	•3420201	•3639702	27	•1160929	•1168832
10	•3090170	•3249197	28	•1119644	•1126729
11	•2817325	•2936264	29	•1081190	•1087566
12	•2580190	•2679492	30	•1045285	•1051042
13	•2393156	•2464778	31	•1011682	•1016900
14	•2225209	•2282434	32	•0980171	•0984914
15	•2079117	•2125566	33	•0950560	•0954884
16	•1950903	•1989124	34	•0922684	•0926637
17	•1837492	•1869321	35	•0896393	•0900016
18	•1736482	•1763270	36	•0871557	•0874087
19	•1645945	•1668704	37	•0848059	•0851124
20	•1561345	•1583944			

HYPERBOLIC LOGARITHMS OF NUMBERS,

FROM 1 to 100.

No.	Logarithm.	No.	Logarithm.	No.	Logarithm.
2	0•69314718	35	3•55534806	68	4•21950771
3	1•09901229	36	3•58351894	69	4•23410650
4	1•38629436	37	3•61091791	70	4•24849524
5	1•60943791	38	3•63758616	71	4•26267988
6	1•79176947	39	3•66356165	72	4•27666612
7	1•94591015	40	3•68887945	73	4•29045944
8	2•07944154	41	3•71357207	74	4•30406509
9	2•19722458	42	3•73766962	75	4•31748811
10	2•30250509	43	3•76120012	76	4•33073334
11	2•39789527	44	3•78418963	77	4•34380542
12	2•48490665	45	3•80666249	78	4•35670883
13	2•56494936	46	3•82864140	79	4•36944785
14	2•63905733	47	3•85014760	80	4•38202663
15	2•70805020	48	3•87120101	81	4•39444915
16	2•77258872	49	3•89182030	82	4•40671925
17	2•83321334	50	3•91202301	83	4•41884061
18	2•89037176	51	3•93182563	84	4•43081680
19	2•94443098	52	3•95124372	85	4•44265126
20	2•99573227	53	3•97029191	86	4•45434730
21	3•04452244	54	3•98898405	87	4•46590812
22	3•09104245	55	4•00733319	88	4•47733631
23	3•13549422	56	4•02535169	89	4•48863637
24	3•17805383	57	4•04305127	90	4•49980967
25	3•21887582	58	4•06044301	91	4•51085951
26	3•25809654	59	4•07753744	92	4•52178858
27	3•29583697	60	4•09434456	93	4•53259949
28	3•33220451	61	4•11087386	94	4•54329478
29	3•36729583	62	4•12713439	95	4•55387689
30	3•40119738	63	4•14313473	96	4•56434819
31	3•43390720	64	4•15888308	97	4•57471098
32	3•46573590	65	4•17438727	98	4•58496743
33	3•49650716	66	4•18965474	99	4•59511885
34	3•52636052	67	4•20469262	100	4•60517019

A TABLE

SHOWING THE CUBIC CONTENT OF TIMBER IN A SQUARE YARD OF JOISTING, OR OTHER SCANTLINGS OF VARIOUS SIZES; AND FROM TWENTY-FOUR INCHES TO THIRTEEN INCHES FROM CENTRE TO CENTRE, UPON THE SUPPOSITION THAT AN EXTRA JOIST IS REQUIRED AT EVERY EIGHTEEN FEET SPACE.

Size of Scantling.	Central Distance.	Cubic Timber in a Square Yard.				Size of Scantling.	Central Distance.	Cubic Timber in a Square Yard.				Size of Scantling.	Central Distance.	Cubic Timber in a Square Yard.									
		in.	ft.	in.	pts. sec.			in.	ft.	in.	pts. sec.			in.	ft.	in.	pts. sec.						
12 inches by 3 inches.	24	1	3	0	0	11 inches by 3 inches.	24	1	1	9	0	10 inches by 3 inches.	24	1	0	6	0	9 inches by 3 inches.	24	0	7	6	0
	23	1	3	7	0		23	1	2	3	5		23	1	0	11	10		23	0	7	9	6
	22	1	4	2	8		22	1	2	10	6		22	1	1	6	3		22	0	8	1	4
	21	1	4	11	1		21	1	3	6	2		21	1	2	1	3		21	0	8	5	6
	20	1	5	8	4		20	1	4	2	8		20	1	2	9	0		20	0	8	10	2
	19	1	6	6	7		19	1	5	0	1		19	1	3	5	6		19	0	9	3	3
	18	1	7	6	0		18	1	5	10	6		18	1	4	3	0		18	0	9	9	0
	17	1	8	6	8		17	1	6	10	2		17	1	5	1	7		17	0	10	3	4
	16	1	9	9	0		16	1	7	11	3		16	1	6	1	6		16	0	10	10	6
	15	1	11	1	2		15	1	9	2	1		15	1	7	3	0		15	0	11	6	7
	14	2	0	7	8		14	1	10	7	1		14	1	8	6	5		14	0	11	3	10
	13	2	2	5	1		13	2	0	2	8		13	1	10	0	3		13	1	7	9	10
8 inches by 3 inches.	24	0	10	0	0	7 inches by 3 inches.	24	0	8	9	0	6 inches by 3 inches.	24	0	7	6	0	5 inches by 3 inches.	24	0	6	3	0
	23	0	10	4	8		23	0	9	1	1		23	0	7	9	6		23	0	6	5	11
	22	0	10	9	9		22	0	9	5	7		22	0	8	1	4		22	0	6	9	1
	21	0	11	3	5		21	0	9	10	6		21	0	8	5	6		21	0	7	0	7
	20	0	11	9	7		20	0	10	3	10		20	0	8	10	2		20	0	7	4	6
	19	1	0	4	5		19	0	10	9	10		19	0	9	3	3		19	0	7	8	9
	18	1	1	0	0		18	0	11	4	6		18	0	9	9	0		18	0	8	1	6
	17	1	1	8	5		17	0	11	11	11		17	0	10	3	4		17	0	8	6	9
	16	1	2	6	0		16	1	0	8	3		16	0	10	10	6		16	0	9	0	9
	15	1	3	4	9		15	1	1	5	8		15	0	11	6	7		15	0	9	7	6
	14	1	4	5	1		14	1	2	4	6		14	1	0	3	10		14	0	10	3	2
	13	1	5	7	5		13	1	3	5	0		13	1	1	2	6		13	0	11	0	1
4 inches by 3 inches.	24	0	5	0	0	3 inches by 3 inches.	24	0	3	9	0	12 inches by 2½ inches.	24	1	0	6	0	11 inches by 2½ inches.	24	0	11	5	6
	23	0	5	2	4		23	0	3	10	9		23	1	0	11	10		23	0	11	10	10
	22	0	5	4	11		22	0	4	0	8		22	1	1	6	3		22	1	0	4	9
	21	0	5	7	8		21	0	4	2	9		21	1	2	1	3		21	1	0	11	2
	20	0	5	10	9		20	0	4	5	1		20	1	2	9	0		20	1	1	6	3
	19	0	6	2	2		19	0	4	7	8		19	1	3	5	6		19	1	2	2	1
	18	0	6	6	0		18	0	4	10	6		18	1	4	3	0		18	1	2	10	9
	17	0	6	10	3		17	0	5	1	8		17	1	5	1	7		17	1	3	8	5
	16	0	7	3	0		16	0	5	5	3		16	1	6	1	6		16	1	4	7	5
	15	0	7	8	5		15	0	5	9	3		15	1	7	3	0		15	1	5	7	9
	14	0	8	2	7		14	0	6	1	11		14	1	8	6	5		14	1	6	9	11
	13	0	8	9	8		13	0	6	7	3		13	1	10	0	3		13	1	8	2	3
10 inches by 2½ inches.	24	0	10	5	0	9 inches by 2½ inches.	24	0	9	4	6	8 inches by 2½ inches.	24	0	8	4	0	7 inches by 2½ inches.	24	0	7	3	6
	23	0	10	9	11		23	0	9	8	11		23	0	8	7	11		23	0	7	6	11
	22	0	11	3	3		22	0	10	1	8		22	0	9	0	2		22	0	7	10	8
	21	0	11	9	1		21	0	10	6	11		21	0	9	4	10		21	0	8	2	9
	20	1	0	3	6		20	0	11	0	9		20	0	9	10	0		20	0	8	7	3
	19	1	0	10	7		19	0	11	7	2		19	0	10	3	8		19	0	9	0	3
	18	1	1	6	6		18	1	0	2	3		18	0	10	10	0		18	0	9	5	9
	17	1	2	3	4		17	1	0	10	2		17	0	11	5	1		17	0	9	11	11
	16	1	3	1	3		16	1	1	7	2		16	1	0	1	0		16	0	10	6	11
	15	1	4	0	6		15	1	2	5	3		15	1	0	10	0		15	0	11	2	9
	14	1	5	1	4		14	1	3	4	10		14	1	1	8	0		14	0	11	11	9
	13	1	6	4	3		13	1	4	6	2		13	1	2	8	0		13	1	0	10	0

Size of Scantling.	Central Distance.	Cubic Timber in a Square Yard.				Size of Scantling.	Central Distance.	Cubic Timber in a Square Yard.				Size of Scantling.	Central Distance.	Cubic Timber in a Square Yard.				Size of Scantling.	Central Distance.	Cubic Timber in a Square Yard.						
		ft.	in.	pts.	sec.			ft.	in.	pts.	sec.			ft.	in.	pts.	sec.			ft.	in.	pts.	sec.			
6 inches by 2½ inches.	24	0	6	3	0	5 inches by 2½ inches.	24	0	5	2	6	4 inches by 2½ inches.	24	0	4	2	0	3 inches by 2½ inches.	24	0	3	1	6			
	23	0	6	5	11		23	0	5	4	11		23	0	4	3	11		23	0	3	3	0			
	22	0	6	9	1		22	0	5	7	7		22	0	4	6	1		22	0	3	4	7			
	21	0	7	0	7		21	0	5	10	6		21	0	4	8	5		21	0	3	6	4			
	20	0	7	4	6		20	0	6	1	9		20	0	4	11	0		20	0	3	8	3			
	19	0	7	8	9		19	0	6	5	3		19	0	5	1	10		19	0	3	10	4			
	18	0	8	1	6		18	0	6	9	3		18	0	5	5	0		18	0	4	0	9			
	17	0	8	6	9		17	0	7	1	8		17	0	5	8	6		17	0	4	3	5			
	16	0	9	0	9		16	0	7	6	8		16	0	6	0	6		16	0	4	6	5			
	15	0	9	7	6		15	0	8	0	3		15	0	6	5	0		15	0	4	9	9			
14	0	10	3	3	14	0	8	6	8	14	0	6	10	2	14	0	5	1	7							
13	0	11	0	2	13	0	9	2	1	13	0	7	4	1	13	0	5	6	1							
2 inches by 2½ inches.	24	0	2	1	0	12 inches by 2 inches.	24	0	10	0	0	11 inches by 2 inches.	24	0	9	2	0	10 inches by 2 inches.	24	0	8	4	0			
	23	0	2	2	0		23	0	10	4	8		23	0	9	6	3		23	0	8	7	11			
	22	0	2	3	1		22	0	10	9	9		22	0	9	11	0		22	0	9	0	2			
	21	0	2	4	3		21	0	11	3	5		21	0	10	4	1		21	0	9	4	10			
	20	0	2	5	6		20	0	11	9	7		20	0	10	9	9		20	0	9	10	0			
	19	0	2	6	11		19	0	1	0	4		5	19	0	11	4		1	19	0	10	3	8		
	18	0	2	8	6		18	0	1	1	0		0	18	0	11	11		0	18	0	10	10	0		
	17	0	2	10	3		17	0	1	1	3		5	17	0	1	0		6	9	17	0	11	5	1	
	16	0	3	0	3		16	0	1	2	6		0	16	0	1	1		3	6	16	0	1	0	1	0
	15	0	3	2	6		15	0	1	3	4		9	15	0	1	2		1	4	15	0	1	0	10	0
14	0	3	5	1	14	0	1	4	5	1	14	0	1	3	0	9	14	0	1	1	8	4				
13	0	3	8	1	13	0	1	5	7	4	13	0	1	4	1	9	13	0	1	2	8	2				
9 inches by 2 inches.	24	0	7	6	0	8 inches by 2 inches.	24	0	6	8	0	7 inches by 2 inches.	24	0	5	10	0	6 inches by 2 inches.	24	0	5	0	0			
	23	0	7	9	6		23	0	6	11	1		23	0	6	0	9		23	0	5	2	4			
	22	0	8	1	4		22	0	7	2	6		22	0	6	3	9		22	0	5	4	11			
	21	0	8	5	7		21	0	7	6	4		21	0	6	7	0		21	0	5	7	9			
	20	0	8	10	2		20	0	7	10	5		20	0	6	10	7		20	0	5	10	10			
	19	0	9	3	3		19	0	8	2	11		19	0	7	2	7		19	0	6	2	3			
	18	0	9	9	0		18	0	8	8	0		18	0	7	7	0		18	0	6	6	0			
	17	0	10	3	4		17	0	9	1	7		17	0	8	0	0		17	0	6	10	3			
	16	0	10	10	6		16	0	9	8	0		16	0	8	5	6		16	0	7	3	0			
	15	0	11	6	7		15	0	10	3	2		15	0	8	11	9		15	0	7	8	5			
14	1	0	3	10	14	0	10	11	5	14	0	9	7	0	14	0	8	2	7							
13	1	1	2	7	13	0	11	8	11	13	0	10	3	4	13	0	8	9	8							
5 inches by 2 inches.	24	0	4	2	0	4 inches by 2 inches.	24	0	3	4	0	3 inches by 2 inches.	24	0	2	6	0	2 inches by 2 inches.	24	0	1	8	0			
	23	0	4	4	0		23	0	3	5	7		23	0	2	7	2		23	0	1	8	9			
	22	0	4	6	1		22	0	3	7	3		22	0	2	8	6		22	0	1	9	7			
	21	0	4	8	5		21	0	3	9	2		21	0	2	9	11		21	0	1	10	7			
	20	0	4	11	0		20	0	3	11	3		20	0	2	11	5		20	0	1	11	7			
	19	0	5	1	10		19	0	4	1	6		19	0	3	1	1		19	0	2	0	9			
	18	0	5	5	0		18	0	4	4	0		18	0	3	3	0		18	0	2	2	0			
	17	0	5	8	7		17	0	4	6	10		17	0	3	5	2		17	0	2	3	5			
	16	0	6	0	6		16	0	4	10	0		16	0	3	7	6		16	0	2	5	0			
	15	0	6	5	0		15	0	5	1	7		15	0	3	10	3		15	0	2	6	9			
14	0	6	10	2	14	0	5	5	9	14	0	4	1	3	14	0	2	8	11							
13	0	7	4	1	13	0	5	10	6	13	0	4	4	11	13	0	2	11	3							
2½ inches by 2 inches.	24	0	2	1	0	3 inches by 1½ inch.	24	0	1	10	6	2½ inches by 1½ inch.	24	0	1	6	9	2 inches by 1½ inch.	24	0	1	3	0			
	23	0	2	2	0		23	0	1	11	5		23	0	1	7	6		23	0	1	3	7			
	22	0	2	3	1		22	0	2	0	4		22	0	1	8	3		22	0	1	4	3			
	21	0	2	4	2		21	0	2	1	5		21	0	1	9	2		21	0	1	5	0			
	20	0	2	5	6		20	0	2	2	7		20	0	1	10	2		20	0	1	5	9			
	19	0	2	6	11		19	0	2	3	10		19	0	1	11	2		19	0	1	6	7			
	18	0	2	8	6		18	0	2	5	3		18	0	2	0	4		18	0	1	7	8			
	17	0	2	10	3		17	0	2	6	10		17	0	2	1	5		17	0	1	8	9			
	16	0	3	0	1		16	0	2	8	8		16	0	2	3	2		16	0	1	9	9			
	15	0	3	2	6		15	0	2	10	8		15	0	2	4	11		15	0	1	11	0			
14	0	3	5	1	14	0	3	1	0	14	0	2	6	10	14	0	1	2	2							
13	0	3	8	1	13	0	3	3	8	13	0	2	9	0	13	0	1	3	2							

SOLIDS.		
Platina, from 16000 to 23000	Chalk, British,	2784
Pure gold, hammered, . . . 19362	Emerald of Peru,	2775
Guinea of George III. . . 17629	Jasper,	2710
Tungsten, . . . 17600	Glass, white,	2892
Mercury at 32° Fahr. . . 13598	. . . . bottle,	2733
Lead, cast, . . . 11352	. . . . green,	2642
Palladium, . . . 11800	Pearl, oriental,	2684
Rodium, . . . 11000	Coral,	2680
Pure silver, . . . 10744	Slate,	2670
Shilling of George III. . . 10534	Granite, Cornish,	2662
Bismuth, molten, . . . 9823	. . . . Aberdeen,	2625
Copper of Japan, . . . 9000	Rock crystal,	2653
. . . . wire-drawn, . . . 8878	Quartz,	2640
. . . . red, molten, . . . 8788	Pebble, English,	2619
Cadmium, . . . 8694	Felspar,	2564
Molybdena, . . . 8611	Stone, common,	2500
Brass, wire-drawn, . . . 8544	Porcelain, China,	2385
. . . . common, cast, . . . 7824	. . . . Limoges,	2341
Arsenic, . . . 8306	Obsidian,	2348
Nickel, molten, . . . 8279	Gypsum,	2280
. . . . forged, . . . 8666	Clay,	2160
Uranium, . . . 8109	Opal,	2114
Meteorite iron, hammered, . . . 7965	Sulphur, native,	2033
Steel, soft, . . . 7833	Brick,	2000
Cobalt, molten, . . . 7812	Ivory,	1917
Bar iron, . . . 7788	Nitre,	1900
Cast iron, Carron, . . . 7248	Alabaster,	1874
Wootz, hammered, . . . 7787	Gunpowder, solid,	1745
Pewter, . . . 7471	Alum,	1714
Tin, hardened, . . . 7299	Phosphorus,	1714
. . . . pure Cornish, . . . 7291	Bone, dry,	1660
Zinc, molten, from 6800 to 7191	Sand,	1500
Wolfiam, . . . 7119	Gum Arabic,	1452
Manganese, . . . 6900	Opium,	1337
Antimony, . . . 6702	Ebony, American,	1331
Tellurium, . . . 6115	Lignumvitæ,	1327
Chromium, . . . 5900	Coal,	1250
Mean of the globe, about 5210	Pitch,	1150
Loadstone, . . . 4930	Rosin,	1100
Spar, heavy, . . . 4430	Amber,	1078
Jargon of Ceylon, . . . 4416	Mahogany,	1063
Ruby, oriental, . . . 4283	Brazil-wood, red,	1031
Garnet, precious, . . . 4230	Boxwood,	1030
. . . . common, . . . 3576	Sodium,	972
Topaz, from 3536 to 4061	Oak, heart of,	950
Sapphire, oriental, . . . 3994	Butter,	942
Diamond, from 3523 to 3550	Ice,	930
Beryl, oriental, . . . 3549	Gunpowder, shaken,	922
English flint glass, . . . 3329	Pumice-stone,	915
Tourmaline, . . . 3155	Logwood,	913
Hornblende, . . . 3000	Living men,	891
Asbestos, . . . 2996	Potassium,	865
Limestone, . . . 2950	Beech,	852
Basalt, . . . 2860	Ash,	845
Marble, Parian, . . . 2837	Apple-tree,	793
. . . . green Campanian, . . . 2742	Maple,	755
. Egyptian, . . . 2668	Citron,	726

SOLIDS.			
Orange tree,	705	Cypress,	598
Walnut,	681	Cedar, American,	561
Pear tree,	661	Fir, male,	550
Hazel,	609	. . . female,	498
Linden tree,	604	Poplar,	383
Elm,	600	Cork,	240
LIQUIDS.			
Sulphuric acid,	1848	Wine of Bordeaux,	994
Boracic acid,	1830	Wine of Burgundy,	991
Nitric acid or Aquafortis,	1500	. . . . red port,	990
Nitrous acid,	1452	Castor-oil,	970
Honey,	1450	Linseed-oil,	940
Water of the Dead Sea,	1240	Proof-spirit,	930
Aqua regia,	1234	Whale-oil,	923
Muriatic acid, of commerce,	1256	Moselle wine,	916
Strong ale, from 1020 to 1050	1050	Olive-oil,	915
Human blood,	1045	Muriatic ether,	874
Milk,	1030	Oil of turpentine,	870
Sea water,	1026	Brandy,	837
Tar,	1015	Alcohol, absolute,	796
Distilled water,	1000	Sulphuric ether,	720
White Champagne,	997	Air at earth's surface,	1·222
GASES.			
Atmospheric air,	1·000	Muriatic acid,	1·280
Hydriodic acid,	4·300	Oxygen,	1·111
Fluosilicic acid,	3·611	Nitrous,	1·042
Chlorine,	2·444	Olefiant,	0·982
Sulphurous acid,	2·222	Nitrogen,	0·972
Cyanogen,	1·805	Ammonia,	0·590
Carbonic acid,	1·524	Hydrogen,	0·069

TABLE OF THE WEIGHT IN POUNDS NECESSARY TO CRUSH CUBES OF ONE AND A HALF INCH IN THE SIDE OF THE FOLLOWING SUBSTANCES, ACCORDING TO MR RENNIE AND OTHERS.

Aberdeen granite, blue,	24536	Craigleith stone across the strata,	12346
White-veined Italian marble,	21738	Dundee sandstone,	14919
Very hard freestone,	21254	Cornish granite,	14302
Purbeck limestone,	20610	White statuary marble,	13632
Limerick limestone, black,	19924	Fine brick,	3864
Peterhead granite,	18636	Yellow baked brick,	2254
Compact limestone,	17354	Red brick,	1817
Yorkshire paving-stone,	15836	Pale red brick,	1265
Craigleith stone with the strata,	15560	Chalk,	1127

TABLE SHOWING THE WEIGHT IN POUNDS THAT WILL PULL ASUNDER A PRISM ONE INCH SQUARE OF THE FOLLOWING MATERIALS, ACCORDING TO THE EXPERIMENTS OF M. MUSCHENBROEK.

Cast gold,	22000	Zinc,	2600
Cast silver,	41000	Bismuth,	2900
Anglesea copper,	34000	Good brass,	51000
Swedish copper,	37000	Ivory,	16270
Cast-iron,	50500	Horn,	8750
Bar-iron, ordinary,	68000	Whalebone,	7500
Ditto, best Swedish,	84000	<i>Compositions.</i>	
Bar-steel, soft,	120000	Gold 5, copper 1,	50000
Ditto, razor-temper,	150000	Silver 5, copper 1,	48500
Cast-tin, Eng. block,	5200	Swedish copper 6, tin 1,	64000
Ditto, grain,	6500	Block-tin 3, lead 1,	10200
Cast-lead,	860	Tin 4, lead 1, zinc 1,	13000
Regulus of Antimony,	1000	Lead 8, zinc 1,	4500

ACCORDING TO THE EXPERIMENTS OF MR RENNIE.

	Weight in lbs. that would tear asunder a prism one inch square.	Length in feet that would break with its own weight.
Cast-steel,	134256	39455
Swedish iron,	72064	19740
English iron,	55872	16938
Cast-iron,	19096	6110
Cast-copper,	19072	5092
Yellow brass,	17958	5180
Cast-tin,	4736	1496
Cast-lead,	1824	384
Good hemp rope,	6400	18790
Ditto, 1 inch diameter,	5026	18790

TABLE OF THE COHESIVE FORCE OF A SQUARE INCH OF IRON OF DIFFERENT KINDS.

Iron wire,	113077	German iron,	69133	Welsh iron,	55776
Ditto,	93964	English iron,	66000	French iron,	61041
Swedish iron,	78850	Ditto,	55000	Russian iron,	59472
Ditto,	72064	Ditto,	61600	Cast-iron,	18295
Ditto,	54960	Ditto,	55772	Ditto,	19488
Ditto,	53244	Welsh iron,	64960	Welsh ditto,	16255

TABLE OF THE LATERAL STRENGTH OF THE FOLLOWING MATERIALS, THE BAR BEING ONE FOOT LONG AND ONE INCH SQUARE

	Weight that will break them.	Weight which they can bear with safety.
Cast-iron,	3270 lbs.	1090 lbs.
Oak,	627	209
Memel fir,	390	130
American white pine,	206	69

TABLE OF POLYGONS.

Names.	No. of sides.	Angle centre.	$\frac{1}{2}$ Angle at Circumf.	Perpendiculars.	Multipliers.
Equilateral triangle,	3	120°	30°	0·2686751	0·4330127
Square,	4	90	45	0·5000000	1·0000000
Pentagon,	5	72	54	0·6881910	1·7204774
Hexagon,	6	60	60	0·8660254	2·5980762
Heptagon,	7	51 $\frac{1}{2}$	64 $\frac{1}{2}$	1·0382607	3·6339124
Octagon,	8	45	67 $\frac{1}{2}$	1·2071068	4·8284272
Nonagon,	9	40	70	1·3737337	6·1818242
Decagon,	10	36	72	1·5388418	7·6942088
Undecagon,	11	32 $\frac{2}{11}$	73 $\frac{7}{11}$	1·7028439	9·3656411
Dodecagon,	12	30	75	1·8660254	11·1961524

TABLE OF THE SURFACES AND SOLIDITIES OF REGULAR BODIES.

No. of faces.	Name.	Surface when the side is 1.	Solidity when the side is 1.
4	Tetraedron,	1·7320508	0·1178511
6	Hexaedron,	6·0000000	1·0000000
8	Octaedron,	3·4641016	0·4714045
12	Dodecaedron,	20·6457788	7·6631189
20	Icosaedron,	8·6602540	2·1816950

TABLE OF THE FLEXIBILITY AND STRENGTH OF TIMBER.

Name of the kind of Wood.	Specific Gravity	Value of U.	Value of E.	Value of S.	Value of C.
Teak,	745	818	9657802	2462	15555
Poon,	579	596	6759200	2221	14787
English oak,	969	598	3494730	1181	9836
Do. specimen 2,	934	435	5806200	1672	10853
Canadian oak,	872	588	8595864	1766	11428
Dantzic oak,	756	724	4765750	1457	7386
Adriatic oak,	993	610	3885700	1533	8808
Ash,	760	395	6580750	2026	17337
Beech,	696	615	5417266	1556	9912
Elm,	553	509	2799347	1013	5767
Pitch pine,	660	588	4900466	1632	10415
Red pine,	657	605	7359700	1341	10000
New England fir,	553	757	5967400	1102	9947
Riga fir,	753	588	5314570	1108	10707
Do. specimen 2,	738	—	3962800	1051	—
Mar Forest fir,	696	588	2581400	1144	9539
Do. specimen 2,	693	403	3478328	1262	10691
Larch,	531	411	2465433	653	—
Do. specimen 2,	522	518	3591133	832	—
Do. specimen 3,	556	518	4210830	1127	7655
Do. specimen 4,	560	518	4210830	1149	7352
Norway spar,	577	648	5832000	1474	12188

Numbers frequently used in Calculation.		Logarithms.	Arithmetical Complements.
Hyperbolic logarithm of 10	= 2·302585092994045684	0·362216	9·637784
Reciprocal of ditto, or			
Modulus of common logs. = M	} = 434294481903251828	9·637784	0·362216
Circumf. of a circle to diameter 1			
Surface of a sphere to diameter 1	} = 3·141592653589793	0·497150	9·502850
Area of circle to radius 1			
Square of 3·14159265359	= 9·869604399639	0·994300	9·005700
Area of a circle to diameter 1	= 785398163397448.....	9·895090	0·104910
Surface of a sphere to radius 1	= 12·566370614.....	1·099210	8·900790
Solidity of a sphere to radius 1	= 4·188790205.....	0·622089	9·377911
Square of circumference of circle x 0·7957747 = area.....		8·900790	1·099210
Solidity of sphere to diameter 1	= 523598775598298.....	9·718999	0·281001
Radius equal to the arc of 57·295779513 degrees.....		1·758123	8·241877
Ditto ditto 3437·74677 minutes.....		3·536274	6·463726
Ditto ditto 206264·81 seconds.....		5·314425	4·685575
Length of an arc of 1 second = 0·000048481368.....		4·685575	5·314425
Ditto of 1 minute = 0·00290888208.....		6·463726	3·536274
Ditto of 1 degree = 0·1745329248.....		8·241877	1·758123
Sine of an arc of 1 second = 0·000048481368.....		4·685575	5·314425
Ditto of 2 seconds = 0·0000096962736.....		4·986605	5·013395
Ditto of 3 seconds = 0·000145444104.....		5·162696	4·837304
A circle = 360 degrees.....		2·556303	7·443697
Ditto = 21600 minutes.....		4·334454	5·665546
Ditto = 1296000 seconds.....		6·112605	3·887395
One hour = 3600 seconds.....		3·556303	6·443697
Twelve hours = 43200 seconds.....		4·635484	5·364516
Twenty-four hours = 86400 seconds.....		4·936514	5·063486
Mean diameter of the earth = 7912 miles.....		3·898286	6·101714
Mean radius of the earth = 20887680 feet.....		7·819890	2·680110
Radius of the equator = 20921180 feet.....		7·320586	2·679414
A degree on the equator = 365144 feet.....		5·562464	4·437536
Earth's polar axis = 41706360 feet.....		7·620202	2·379798
English mile = 5280 feet.....		3·722634	6·277366
Geographical or nautical mile = 6075·6 feet.....		3·783589	6·216411
Time of the diurnal rotation of the earth = 86164·0908 sec.		4·935326	5·064674
Length of the solar or tropical year = 365·24223 days.....		2·562581	7·437419
Length of seconds pendulum at Edinburgh = 39·1555 in.		1·592793	8·407207
Force of gravity at Edinburgh = 32·2041 feet.....		1·507911	8·492089
Length of seconds pendulum at London = 39·1393 inches		1·592613	8·407387
Force of gravity at London = 32·1908 feet.....		1·507732	8·492268
Length of the French toise = 6·39495 imperial feet.....		0·805837	9·194163
Ditto ditto pied = 1·065825 imperial foot.....		0·027686	9·972314
Ditto ditto metre = 3·2808992 imperial feet ..		0·515993	9·484007
Myriametre = 6·2138 imperial miles		0·793358	9·206642
Square metre = 1·196033 square yard.....		0·077743	9·922257
French hectare = 2·47114 imperial acres.....		0·392898	9·607102
Cubic metre = 35·3166 imperial cubic feet.....		1·547979	8·452021
French gramme = 15·434 imperial Troy grains.....		1·188479	8·811521
Litre = 1·760773 imperial pint.....		0·245703	9·754297
Hectolitre = 22·009668 imperial gallons.....		1·342613	8·657387
Imperial yard = 0·91438348 metre.....		9·961128	0·038872
Imperial mile = 1609·3149 metres.....		3·206642	6·793358
Square yard = 0·836097 square metre.....		9·922257	0·077743
Imperial acre = 0·404671 hectare.....		9·607102	0·392898
Imperial gallon = 4·54345797 litres.....		0·657387	9·342613
Imperial quarter = 2·907813 hectolitres.....		0·463566	9·536434

THE END.

Printed by Oliver & Boyd,
Tweeddale Court, High Street, Edinburgh.

